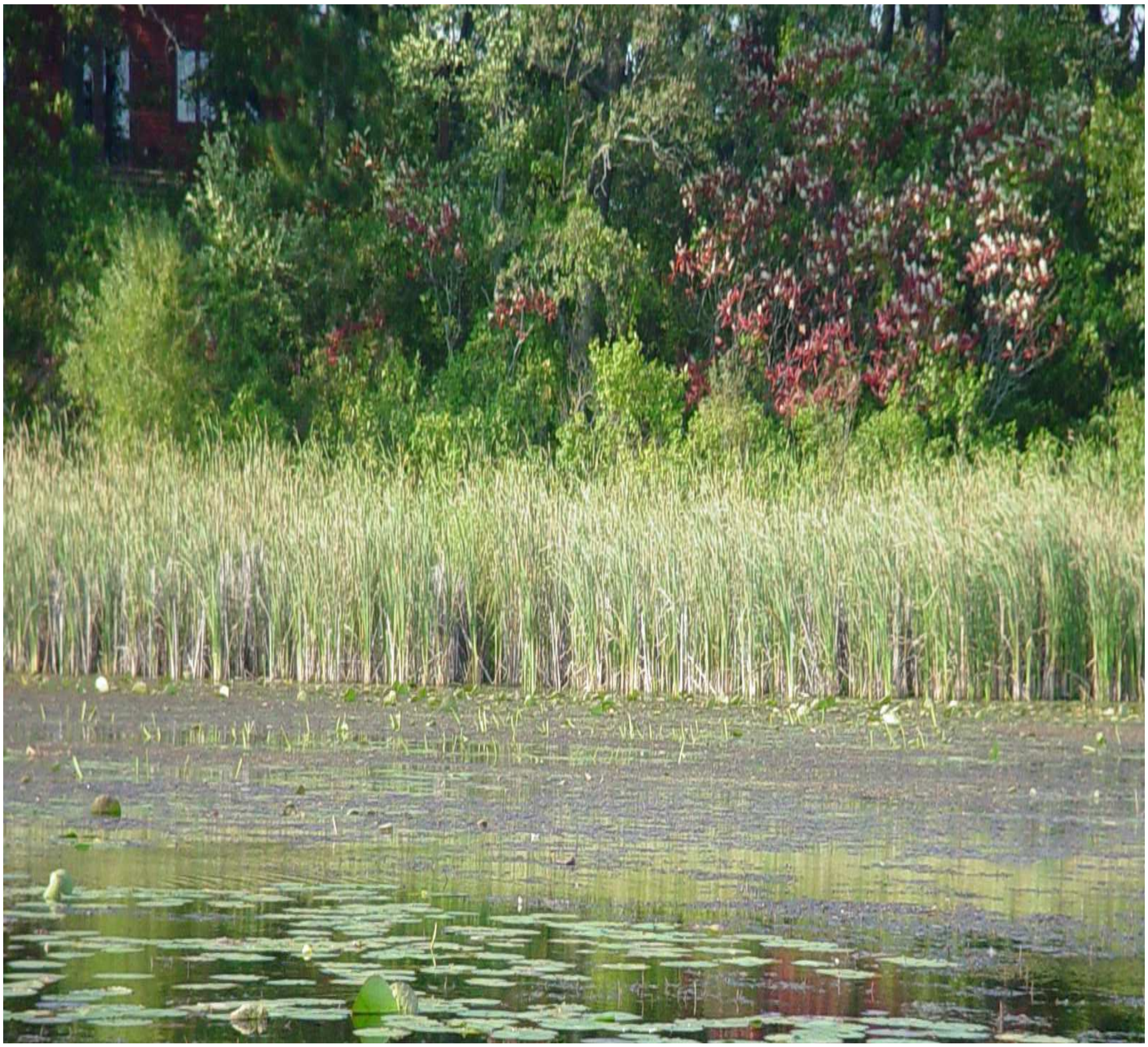
LAKE CLASSIFICATION REPORT
GOOSE LAKE, ADAMS COUNTY



Presented by Reesa Evans, CLM, Lake Specialist
Adams County Land & Water Conservation Department
P.O. Box 287, Friendship, WI 53934

MARCH 2008

GOOSE LAKE
LAKE CLASSIFICATION REPORT
TABLE OF CONTENTS

EXECUTIVE SUMMARY

Background Information about Goose Lake

Goose Lake is a 84.4-acre natural seepage lake located mainly in the Town of Jackson, Adams County, in the Central Sand Plains Area of Wisconsin. According to the WDNR depth map, it has a maximum depth of 18 feet and an average depth of 7 feet. A "seepage lake" is a natural lake with no natural stream inlet or outlet and fed by precipitation, runoff and groundwater

Goose Lake is part of the Neenah Creek Watershed, a large watershed of 182 square miles which flows into the Fox River and eventually into Lake Michigan. There is a public boat ramp on the east side of the lake, owned by the Town of Jackson.

The two primary soil types in the surface watershed for Goose Lake are sand and loamy sand, with slopes from very flat up to 25%. There is also a large portion of muck soil on the northwest side of the lake, where there are extensive wetlands and little development. Loamy sands dominate the ground watershed, followed fairly closely by sand. These soils tend to be well- to excessively drained, no matter what the slope. Water, air and nutrients move through these soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. These soils have little water-holding capacity and low natural fertility. Water erosion, wind erosion & drought are all hazards with these soils, especially since they dry out so quickly. Onsite waste disposal in these soils is also a problem because of slope and seepage; mound systems are usually required.

Land Use in Goose Lake Watersheds

Both the surface and ground watersheds of Goose Lake are fairly small. The most common land uses in the Goose Lake Surface Watershed are woodlands and residential. In the ground watershed, woodlands and non-irrigated agriculture are the major land uses.

There are extensive wetlands located around much of Goose Lake's immediate shores. In the past few years, as the lake level has declined, some areas in these wetlands have become exposed and seem to be slowly drying out, unless the lake level comes back up to cover these areas.

Goose Lake has a total shoreline of 2.8 miles (14784 feet). Over half of the immediate shore area is in residential. There are no residences on the northeast side of the lake, where there is an extensive wetland. Some of the area near the shore is steeply sloped. Several of the older cottages are located very close to the shore. 81.27% (12015 feet) of Goose Lake's shoreline is vegetated.

A 2004 inventory included classifying areas of the Goose Lake shorelines as having "adequate" or "inadequate" buffers. An "adequate" buffer was defined as one having the first 35 feet landward covered by native vegetation. An "inadequate" buffer was anything that didn't meet the definition of "adequate buffer", including native vegetation strips less than 35 feet landward. Using these definitions, 57.35% (8479.2 feet) of Goose Lake's shoreline had an "adequate buffer", leaving 42.65% (6304.8 feet) as "inadequate." Most of the "inadequate" buffer areas were found with mowed lawns and/or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line.

Water Testing Results

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on Goose Lake. Overall, Goose Lake was determined to be a mesotrophic lake with good water quality and water clarity.

Measuring the phosphorus in a lake system provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. The 2004-2006 summer average phosphorus concentration in Goose Lake was 16.85 micrograms/liter. This is below the 25 micrograms/liter average recommended for natural lakes in Wisconsin to avoid algal blooms. This concentration suggests that Goose Lake is likely to have few nuisance algal blooms. This places Goose Lake in the "good" water quality section.

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Goose Lake in 2004-2006 was 7.1 feet. This is good water clarity.

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. The 2004-2006 summer (June-September) average chlorophyll-a concentration in Goose Lake was 5.63 micrograms/liter, a low algal concentration.

Low dissolved oxygen levels during the summer in the bottom waters of a lake occurs naturally as oxygen in the bottom layer is consumed, but not replenished. As the summer progresses, the oxygen concentration of the bottom waters may decrease. In Goose Lake, there were hypoxic (low oxygen) periods in the lower depths of the lake during the summers of 2004 and 2005. Besides being a potential danger to a lake's fish population, summer hypoxia can result in phosphorus being released into the upper water column and being available for algal blooms and increased aquatic plant growth. The data collected at Goose Lake from 2004-2006 shows there is a potential for phosphorus loading from the lower depths (hypolimnion) during the summer months in Goose Lake if the hypoxia/anoxia continues. Dissolved oxygen needs to be monitored during the late summer months in the lower depths on Goose Lake to determine whether hypoxia/anoxia is a frequently-occurring condition that may need to be addressed by management practices.

Water testing results for Goose Lake showed "hard" water (90.67 mg/l $CaCO_3$). Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water. Average alkalinity in Goose Lake during the testing period was 92 ueq/l.

A lake with a neutral or slightly alkaline pH like Goose Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water Goose Lake.

Other water quality testing at Goose Lake showed no particular areas of concern. The average calcium level in Goose Lake's water during the testing period was 22.31 mg/l. The average Magnesium level was 11.72 mg/l. Both of these are low-level readings. Although the presence of a significant amount of chloride over a period of time may indicate that there are negative human impacts on the water quality present, chloride levels found in Goose Lake during the testing period were all below 3 mg/l, at about the natural level of chloride in this area of Wisconsin. Nitrogen levels can also affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 mg/l in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Goose Lake combination nitrogen levels from 2004 to 2006 did rise to .61 mg/l, well above the .3 mg/l predictive level for algal blooms. Given appropriate conditions, Goose Lake might suffer nitrogen-related algal blooms.

Both sodium and potassium levels in Goose Lake were very low: the average sodium level was 1.65 mg/l; the average potassium reading was .58 mg/l. To prevent the formation of H_2S, levels of 10 mg/l are best. A health advisory kicks in at 30 mg/l.

Goose Lake sulfate levels average 5.48 mg/l during the testing period, far below either level. Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Very turbid waters may not only smell and mask bacteria & other pollutants, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Goose Lake's waters were all at very low levels.

Phosphorus

Like most lakes in Wisconsin, Goose Lake is a phosphorus-limited lake: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other quality aspects.

The total phosphorus (TP) concentration in a lake is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For a natural lake like Goose Lake, a total phosphorus concentration below 25 micrograms/liter tends to indicate few nuisance algal blooms are likely to occur. Goose Lake's growing season (June-September) surface average total phosphorus level of 16.85 micrograms/liter is just above that level, so nuisance algal blooms may occur, but are probably localized.

Land use plays a major role in phosphorus loading. The land uses in the Goose Lake surface watershed that contribute the most phosphorus are non-irrigated agriculture and the ground watershed. Some phosphorus deposition cannot be controlled by humans. However, some phosphorus (and other nutrient) input can be decreased or increased by changes in human land use patterns. Practices such as waterbody shoreland buffer restoration; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake.

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve Goose Lake in-lake water quality by .8 to 4 micrograms of phosphorus/liter; a 25% reduction would save 2 to 10 micrograms/liter. Currently, both the spring turnover and summer phosphorus levels are below the threshold value of 25 micrograms/liter, but a phosphorus increase from human activities of only 25% would put the phosphorus levels in the lake over that threshold in the summer. The result would be more algal blooms and more aquatic plants. Decreases would reduce those problems. The modeling predictions make it clear that reducing current phosphorus human-impacted inputs to the lake are essential to improve, maintain and protect Goose Lake's health for future generations.

Aquatic Plant Community

The Goose Lake aquatic plant community is characterized by high quality and excellent species diversity. The plant community is in the top quartile of lakes in the state and region, the group of lakes closest to an undisturbed condition and with an average sensitivity to disturbance. Several sensitive species were found there, including one on the "special concern" list, *Eleocharis robbinsii* (Robbin's spikerush).

Brasenia schreberi (watershield) was the most frequently-occurring "plant" in Goose Lake in 2006 (67.44% frequency), followed closely by *Myriophyllum spicatum* (62.79%) and *Nymphaea odorata* (60.47%). No other species reached a frequency of 50% or greater.

Brasenia schreberi was also the densest plant in Goose Lake. None of the aquatic vegetation in Goose Lake occurred at more than average density overall in the lake in summer 2006. Based on dominance value, *Brasenia schreberi* was the dominant aquatic plant species in Goose Lake. Subdominant species were the invasive, *Myriophyllum spicatum (*Eurasian watermilfoil), *Najas guadelupensis* (Southern naiad), and *Nymphaea odorata* (white water lily). *Lythrum salicaria* (Purple Loosestrife) *Potamogeton crispus* (Curly-Leaf Pondweed) and *Phalaris arundinacea* (Reed Canarygrass), three other exotics found in Goose Lake, were not present in high frequency, high density or high dominance.

Critical Habitat Areas

Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes. Three areas on Goose Lake—covering much of the lake's shores--were determined by a team of lake professionals to be appropriate for critical habitat designation.

Area GL1 averages 5 feet in depth and contains near-shore habitat, shoreline habitat and shallow water habitat. The basin provides visual and sound buffers and an area of outstanding beauty for lake residents and visitors. Most of the shoreline in this area is undeveloped, although some lots have been occupied since the original 2001 site visit.

Most of the shore is wooded or wetland. Woody material is present in the shallow zone for habitat. The wetlands contain wet meadows, shrubs, evergreen wetlands and deep marsh wetlands. The plant community in this area consists of nine species emergent aquatic plants, three species of floating-leaf rooted plants, and eleven species of submergent plants. Three invasive species, *Lythrum salicaria* (Purple Loosestrife, an emergent), *Myriophyllum spicatum* (Eurasian Watermilfoil, a submergent) and *Phalaris arundinacea* (Reed Canargygrass, an emergent) were found in this area.

Area GL2 averages 6.5 feet in depth and contains near shore habitat, shoreline habitat and shallow water habitat. Most of this shoreline is undeveloped, although some lots have been occupied since the original 2001 site visit. Most of the shore is wooded or wetland. Woody material is present in the shallow zone for habitat. The wetlands contain wet meadows, shrubs wetlands, tamarack bogs, and deep marsh wetlands. The plant community in this area consists of at least eight emergent species, four floating-leaf rooted plant species, and nine species of submergents. Emergents include: sedges, dogwood, water bulrush, marsh fern, tag alder, tamarack, cattail, and bulrush. In 2006, a species of special concern, *Eleocharis robbinsii* (Robbin's Spikerush), was also found in this area. Several other high-quality aquatic species, including *Cephhalanthus occidentalis* (Buttonbush), *Cladium marisicoides* (Twig Rush), *Lysmachia quadriflor* (4-Flower Yellow Loosestrife) and *Sarracenia purpurea* (Purple Pitcher Plant)—were also found in this area. Two invasives, Eurasian Watermilfoil and Reed Canarygrass, were also found in GL2.

Area GL3 was added after a field review in 2006 by WDNR and Adams County Land & Water Conservation Department staff. Although there are houses in this area, most of them are set back substantially from the ordinary high water mark, up the slopes. There are dense beds of plants that provide micro-habitat and sediment stabilization. The area contains near shore habitat, shoreline habitat and shallow water habitat. The area comprises about 1000 feet of shoreline with an average water depth of 4 feet. It is located to the west and south of the public boat ramp on Goose Lake. Vegetation just landward of shore includes mostly native forbs and shrubs, with a small area of traditional lawn and some presence of woody cover. An emergent species of special concern, *Eleocharis robbinsii*, was abundant in this area. Also found were four emergent species, four floating-leaf rooted species, and eleven species of submergent aquatic plants.

Fish/Wildlife/Endangered Resources

WDNR fish stocking records for Goose Lake go back to 1937, when several thousand bullheads were put into the lake. Stocking continued into the 1970s and included more bullheads, as well as bluegill, crappie, largemouth bass, northern pike, perch and sunfish. There was a long history of fish winterkills, until the current aerators were installed. The most recent fish inventory, in 2004, found that bluegills were abundant, largemouth bass were common, but northern pike and black crappie were scarce.

Muskrat and mink are also known to use Goose Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl, songbirds, and turkey. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well.

Conclusion

Goose Lake is currently a fairly healthy lake with many positive aspects, as discussed in this report. The Goose Lake Association developed a lake management plan that has been approved by the WDNR. Care should be taken to maintain the overall very good quality of the lake and its surroundings.

RECOMMENDATIONS

Lake Management Plan

The Goose Lake Association should continue to manage the lake according to its lake management plan. It should be reviewed annually for any necessary changes. It is also recommended that proposed changes should be made with consultation with WDNR and Adams County Land & Water Conservation staff to make sure appropriate information is available for decision-making. The plan should always address at least the following issues: aquatic plant management; control/management of invasive species; wildlife and fishery management; preservation of the wetlands; watershed management; shoreland protection; critical habitat protection; water quality protection.

Watershed Recommendations

Although neither the surface nor ground watershed for Goose Lake is particularly large, results of the modeling certainly suggests that input of nutrients, especially phosphorus, are a factor that needs to be explored for Goose Lake.

Therefore, it is recommended that both the surface and ground watersheds be inventoried, documenting any of the following: runoff from any livestock operations that may be entering the surface water; soil erosion sites; agricultural producers not complying with nutrient management plans and/or irrigation water management plans.

If such sites are documented, steps for dealing with these issues can be incorporated into the lake management plan.

Shoreland Recommendations

> All lake residents should practice best management on their lake properties, including keeping septic systems cleaned and in proper condition, eliminating the use of lawn fertilizers, cleaning up pet wastes and not composting near the water.

Aquatic Species and Invasive Species Management

1) Residents should become involved in the Citizen Lake Water Monitoring Program, Invasive Species Monitoring and Clean Boats, Clean Waters. This will allow not only noting changes in the Eurasian Watermilfoil and the other invasives already identified, but also help identify any new species. Noting the presence and density of these species early is the best way to take preventive action to keep them from becoming a bigger problem.

2) Lake residents should protect and increase natural shoreline in some areas of the lake around Goose Lake, especially where the cottages are very close to the shore. In general, disturbed shoreline sites support an aquatic plant community that is less able to resist invasions of exotic species and shows impacts from nutrient enrichment.

3) All lake users should protect the aquatic plant community in Goose Lake by discouraging disturbance of plant beds, by not removing more native plants that permitted by law, and by removing exotic invasives wherever they see them.

4) The Goose Lake Association should maintain exotic species signs at the boat landings and contact WDNR if the signs are missing or damaged.

5) The Goose Lake Association should monitor Eurasian Watermilfoil and and the other known invasives, as well as investigate options for managing these invasives. Residents should be encouraged to hand-pull scattered invasive plants.

6) Consideration should be given as to whether the Goose Lake Association wants to try to increase the population of the native weevil that attacks Eurasian Watermilfoil.

Critical Habitat Recommendations

There are also several recommendations appropriate for the critical habitat areas.

(1) Maintain current habitat for fish and wildlife.
(2) Do not remove fallen trees along the shoreline nor logs in the water.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain snag/cavity trees for nesting.
(6) Maintain or increase wildlife corridor.

(7) Maintain sedge meadow and deep marsh areas.
(8) Maintain no-wake zone.
(9) Protect emergent vegetation for habitat and shoreline protection.
(10) Removal of submergent vegetation for navigation purposes only.
(11) Seasonal control of Eurasian Watermilfoil and Curly-Leaf Pondweed by using control methods specific for exotics.
(12) Minimize aquatic plant and shore plant removal to maximum 30' wide access/viewing corridor. Leave as much vegetation as possible to protect water quality and habitat.
(13) Use forestry best management practices.
(14) No use of lawn products.
(15) No bank grading or grading of adjacent land.
(16) No pier construction or other activity except by permit using a case-by-case evaluation.
(17) No installation of pea gravel or sand blankets.
(18) No bank restoration unless the erosion index scores moderate or high.
(19) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(20) Placement of swimming rafts or other recreational floating devices only by permit.
(21) Maintain buffer of shoreline vegetation.
(22) Maintain aquatic vegetation in undisturbed condition for wildlife habitat, fish use and water quality protection.
(23) Post landing with exotic species alert and educational signs to prevent introduction and/or spread of exotic species.
(24) Maintain lake as no-motor lake.

LAKE CLASSIFICATION REPORT FOR GOOSE LAKE, ADAMS COUNTY

INTRODUCTION

In 2003, The Adams County Land & Water Conservation Department (Adams County LWCD) determined that a significant amount of natural resource data needed to be collected on the lakes with public access in order to provide it and the public with information necessary to manage the lakes in a manner that would preserve or improve water quality and keep it appropriate for public use. In some instances, there was significant historical data about a particular lake; in that instance, the study activities concentrated on combining and updating information. In other instances, there was no information on a lake, so study activities concentrating on gathering data about that lake. Further, it was discovered that information was scattered among various citizens, so often what information was actually available regarding a particular lake was unknown. To assist in updating some information and gathering baseline information, plus centralize the data collected, so the public may access it. The Adams County LWCD received a series of grants from the Wisconsin Department of Natural Resources (WDNR) from the Lake Classification Grant Program.

Objectives of the study were:

- collect physical data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- collect chemical and biological data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- develop a library of lake information that is centrally located and accessible to the public and to City, County, State and Federal agencies.
- make specific recommendations for actions and strategies for the protection, preservation and management of the lakes and their watersheds.
- create a baseline for future lake water quality monitoring.
- Provide technical information for the development of comprehensive lake management plans for each lake
- provide a basis for the water quality component of the Adams County Land and Water Resource Management Plan. Components of the plan will be incorporated into Adams County's "Smart Growth Plan".
- develop and implement educational programs and materials to inform and education lake area property owners and lake users in Adams County.

METHODS OF DATA COLLECTION

To collect the physical data, the following methods were used:

- delineation & mapping of ground & surface watersheds using topographic maps, ground truthing and computer modeling;
- identification of flow patterns for both the surface & ground watersheds using known flow maps and topographic maps;
- inventory & mapping of current land use with orthographic photos and collected county information;
- inventory & mapping of shoreline erosion and buffers using county parcel maps and visual observation;
- inventory & mapping for historical and cultural sites using information from the local historical society and the Wisconsin Historical Society;
- identification & mapping of critical habitat areas with WDNR and Adams County LWCD staff;
- identification & mapping of endangered or threatened natural resources (including natural communities, plant & animal species) using information from the Natural Heritage Inventory of Wisconsin;
- identification & mapping of wetland areas using WDNR and Natural Resource Conservation Service wetland maps;
- preparation of soil maps for each of the lake watersheds using soil survey data from the Natural Resource Conservation Service.

To collect water quality information, different methods were used:

- for three years, lakes were sampled during late winter, at spring and fall turnover, and several times during the summer for various parameters of water quality, including dissolved oxygen, relevant to fish survival and total phosphorus, related to aquatic plant and algae growth;
- random samples from wells in each lake watershed were taken in two years and tested for several factors;
- aquatic plant surveys were done on all 20 lakes and reports prepared, including identification of exotics, identifying existing aquatic plant community, evaluation of community measures, mapping of plant distribution, and recommendations;
- all lakes were evaluated for critical habitat areas, with reports and recommendations being made to the respective lakes and the WDNR;
- lake water quality modeling was done using data collected, as well as historical data where it was available.

WATER QUALITY COMPUTER MODELING

Wisconsin developed a computer modeling program called WiLMS (Wisconsin Lake Modeling Suite) to assist in determining the amount of phosphorus being loaded annually into a lake, as well as the probable source of that phosphorus. This suite has many models, including Lake Total Phosphorus Prediction, Lake Eutrophic Analysis Procedure, Expanded Trophic Response, Summary Trophic Response, Internal Load Estimator, Prediction & Uncertainty Analysis, and Water & Nutrient Outflow. The models that various types of data inputs: known water chemistry; surface area of lake; mean depth of lake; volume of lake; land use types & acreage. This information is then used in the various models to determine the hydrologic budget, estimated residence time, flushing rate, and other parameters.

Using the data collected over the course of the studies, various models were run under the WiLMS Suite. These water quality models are computer-based mathematical models that simulate lake water quality and watershed runoff conditions. They are meant to be a tool to assist in predicting changes in water quality when watershed management activities are simulated. For example, a model might estimate how much water quality improvement would occur if watershed sources of phosphorus inputs were reduced. However, it should be understood that these models predict only a relative response, not an exact response. Modeling results will be incorporated into topic discussions as appropriate.

DISSEMINATION OF PROJECT DELIVERABLES

The results of this study will be distributed various agencies, organizations and the public as previously described. Based on the classification information, the Adams County Land and Water Conservation Department will identify assistance requests and determine the appropriate future activities, based on the classification determinations. To provide the requested assistance, Adams County Land and Water Conservation Department will incorporate the lake management plans goals, priorities and action items into its Annual Plan of Operations. Goals, priorities and action items may include educational programs, formation of lake districts, further development of lake management plans and implementation of lake management plans.

ADAMS COUNTY INFORMATION

Adams County lies in south central Wisconsin, shaped roughly like the outline of Illinois. Adams County is a small rural county with a full-time population of about 20,000. Between 1980 and 2000, Adams County's population grew by more than 20%, with most of the population increase being located upon the lakes and streams. The population increase has resulted in a greater need for facilitation, technical assistance and education, including information on the lakes and streams.

Figure 1: Adams County Location in Wisconsin

GOOSE LAKE BACKGROUND INFORMATION

Goose Lake is an 84.4-acre natural seepage lake located mainly in the Town of Jackson, Adams County, in the Central Sand Plains Area of Wisconsin. According to the WDNR depth map, it has a maximum depth of 18 feet and an average depth of 7 feet. A "seepage lake" is a natural lake with no natural stream inlet or outlet and fed by precipitation, runoff and groundwater. There is a public boat ramp, owned by the Town of Jackson, in the east lobe of the lake, as well as a small public swimming area. There is a walk-in public access lot off of County G on the west side of the lake. Extensive wetlands are found on the northwest side of the lake.

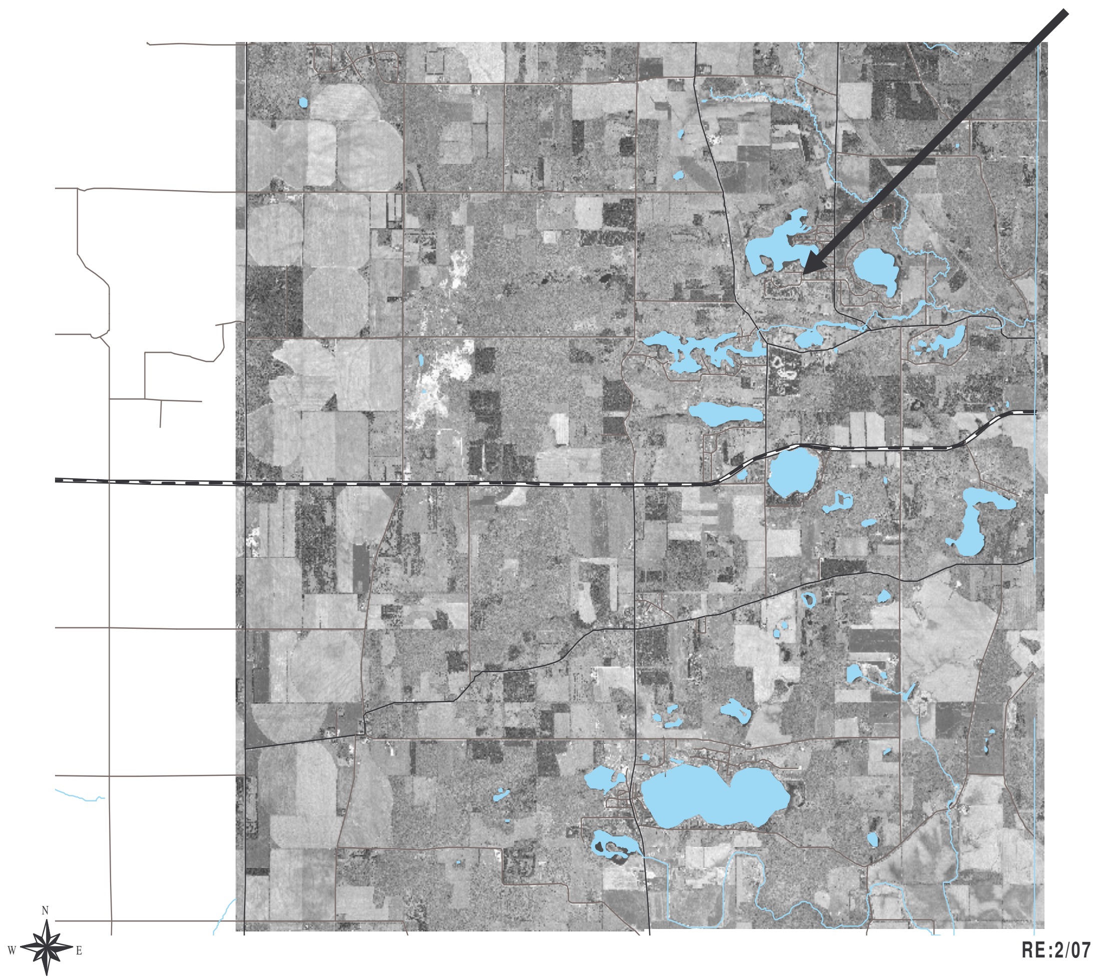


Figure 2: GOOSE LAKE location

Goose Lake is part of the Neenah Creek Watershed, a large watershed of 182 square miles which flows into the Fox River and eventually into Lake Michigan. The Central Sand Hills, which contain Goose Lake, are an ecological landscape (a recessional moraine) on the eastern edge of what was Glacial Lake Wisconsin. The area is characterized by glacial moraines and glacial outwash, as well as the kettle holes that formed natural lakes—such as Goose Lake. Elevations average between 900 to 1000 feet above sea level.

Bedrock and Historical Vegetation

Bedrock around Goose Lake is mostly sandstone, formed in the Cambrian Period of Geology (542 to 488 millions years ago). Bedrock is generally 50 feet to 100 feet down from the land surface. The topography of this area is a series of glacial moraines that were partly covered by glacial outwash to from glacial plains and hummocky moraines

Original upland vegetation of the area around Goose Lake included oak-forest, oak savanna and tallgrass prairie. Fens were also common, including wet-mesic prairies, wet prairie, and rare coastal plain marshes. The small kettle lakes of this region tend to have fairly soft water.

Soils in the Goose Lake Watersheds

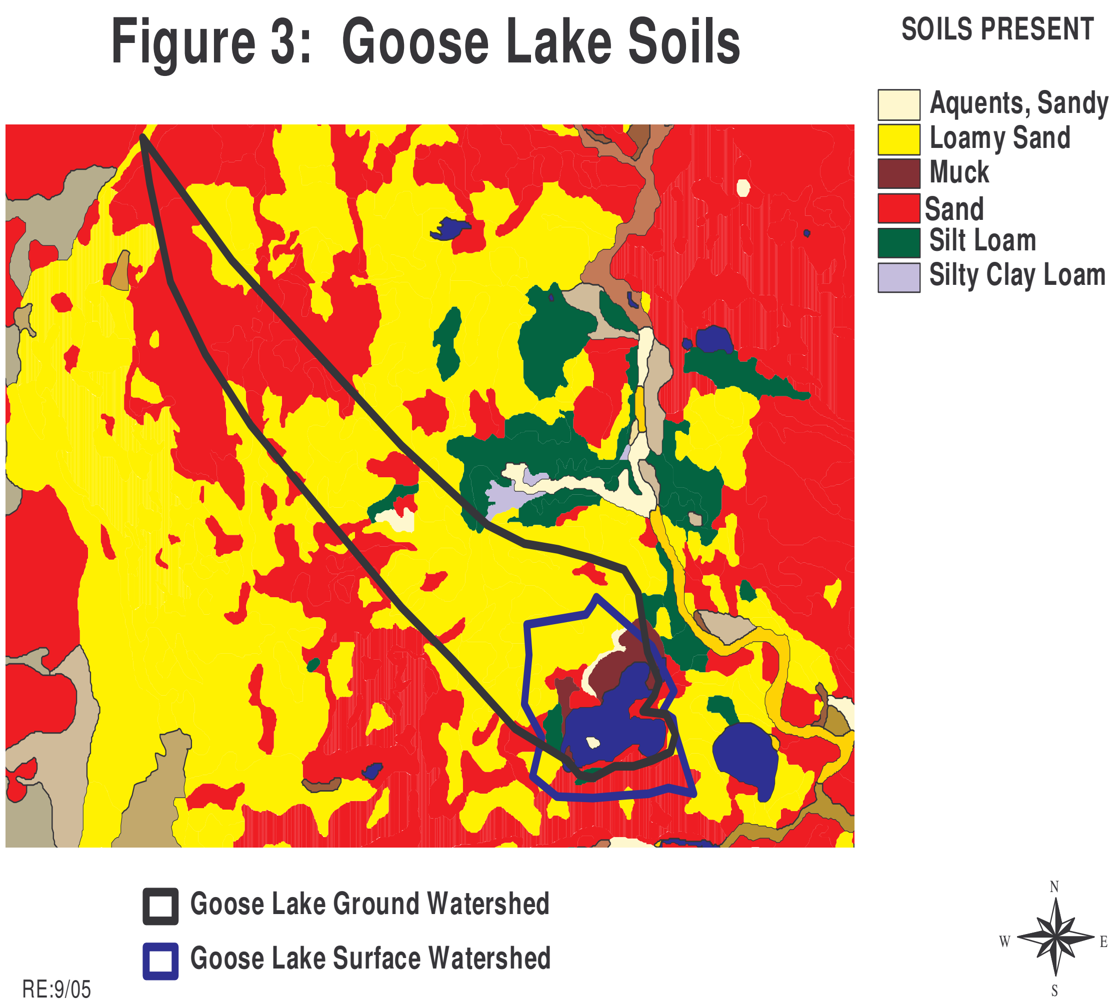
Except for some pockets of loamy fine sand, silt loam, silty clay loam, and muck, the soils in the surface watershed for Goose Lake are loamy sand and sand, in that order, with slopes from very flat up to 25%. Sandy and loamy sand are split nearly evenly the ground watershed.

Sandy soils tend to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since they dry out so quickly. There are also draught hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. The same difficulties with waste disposal and vegetation establishment are present with loamy sands as with sandy soils.

The soil and soil slopes around lakes and streams are very important to water quality. They affect amount of infiltration of surface precipitation into the ground and the amount of contaminants that may reach the groundwater, as well as the amount of surface stormwater runoff. In addition, these two factors affect the amount and content of pollutants and particles (including soil) that may wash into a water body, affecting its water quality, its aquatic plant community and its fishery. Further, soil types and soil slopes help determine the appropriate private sewage system and other engineering practices for a particular site, since they affect absorption, filtration and infiltration of contamination from engineering practices.

Figure 3: Goose Lake Soils



CURRENT LAND USE

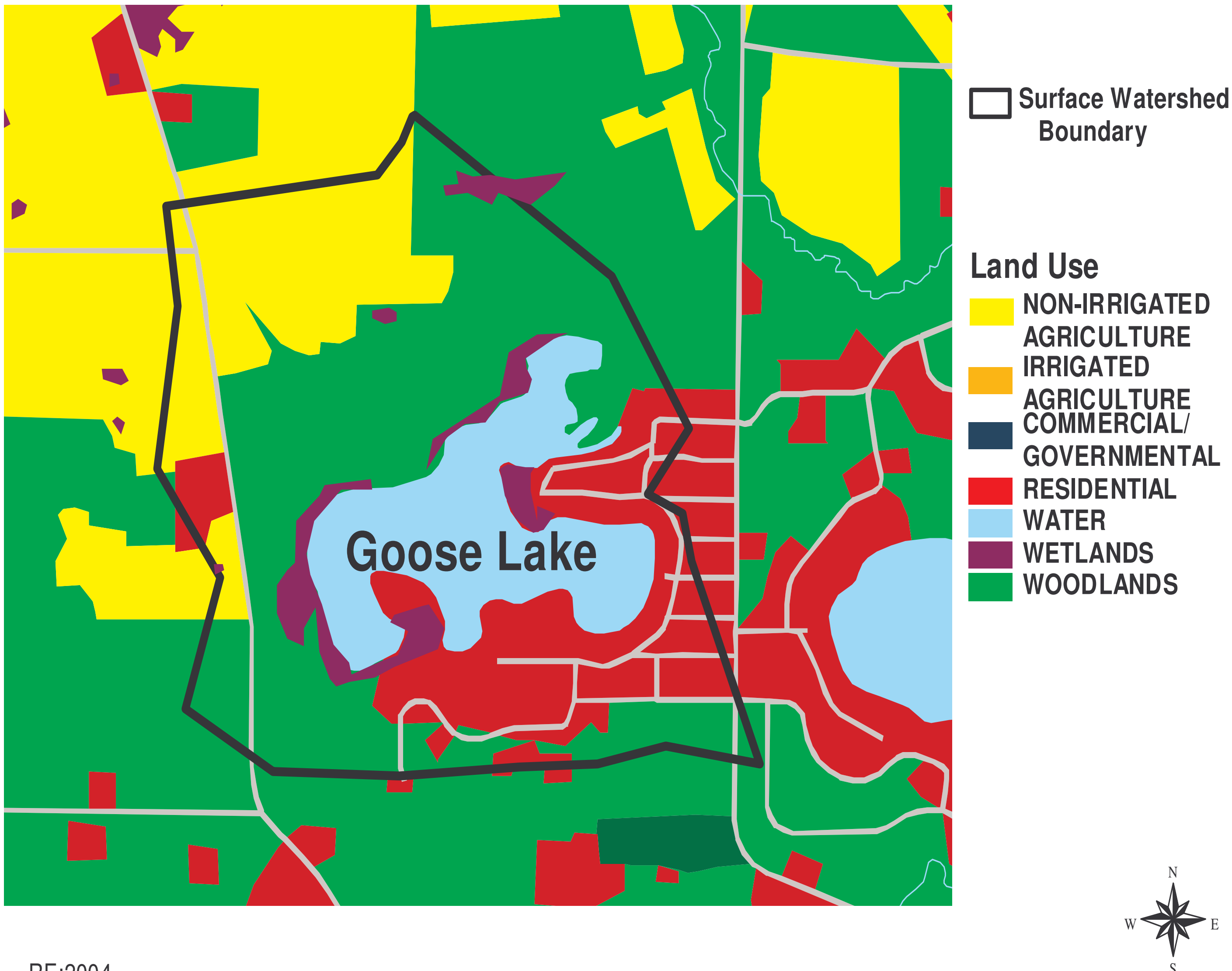
Both the surface and ground watersheds of Goose Lake are fairly small. The most common current land uses in the Goose Lake Surface Watershed are woodlands and residential. In the ground watershed, woodlands and non-irrigated agriculture are the major land uses (See Figures 4, 5a, 5, 6a & 6b).

Figure 4: Goose Lake Watersheds Land Use in Acres and Percent of Total

	Surface	% of	Ground	% of	Total	% of Total
Goose Lake	**in acres**	**Total**	**in acres**	**Total**	**in acres**	
Agriculture--Non Irrigated	79.46	17.70%	368.45	36.69%	447.91	30.82%
Agriculture--Irrigated	0	0.00%	94.7	9.43%	94.7	6.52%
Government	0	0.00%	6.3	0.62%	6.3	0.43%
Residential	106.4	23.70%	115.79	11.53%	222.19	15.29%
Water	84.4	18.80%	15.3	1.53%	99.7	6.86%
Woodland	178.68	39.80%	403.69	40.20%	582.37	40.08%
total	448.94	100.00%	1004.23	100.00%	1453.17	100.00%

Studies have shown that land use around a lake has a great impact on the water quality of that lake, especially in the amount and content of surface runoff. (James, T., 1992, I-10; Kibler, D.F., ed. 1982. 271) For example, while natural woodland may (on the average) absorb 3.5 inches out of a 4 inch rainfall, leaving only .5 inch as runoff, a residential area with quarter-acre lots may absorb only 2.3 inches of the 4 inches, leaving 1.7 inches to run off the land into the lake—the same amount as may be expected to run off from a corn or soybean field. 1.7 inches of runoff translates into 46,200 gallons per acre ending up in the lake! Percentage of impervious surface, the soil type, vegetation present and slope of the site can all affect runoff volume. (Frankenberger, J, ID-230).

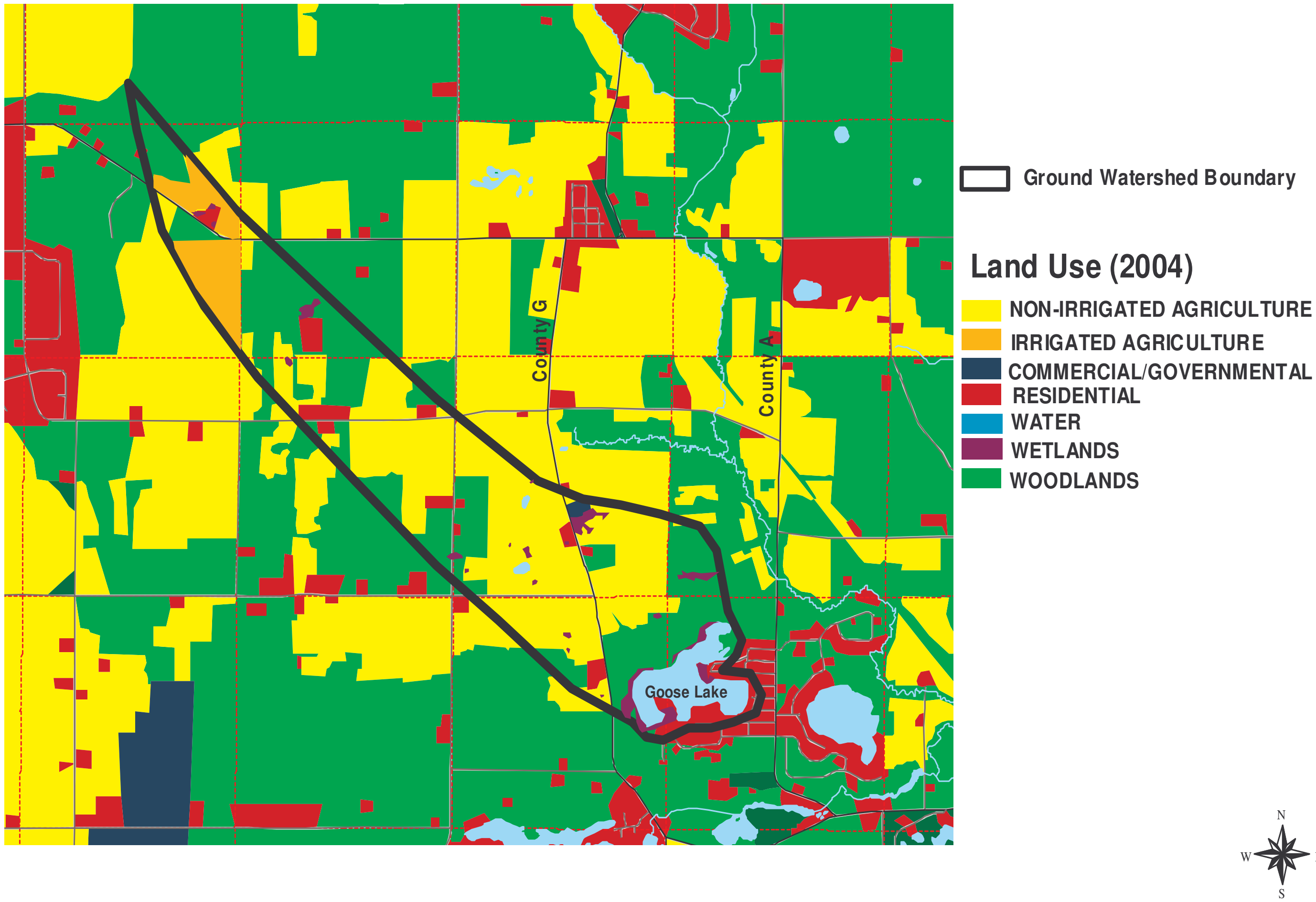
Goose Lake--Surface Watershed



RE:2004

Figure 5a: Land Use in Goose Lake Surface Watershed

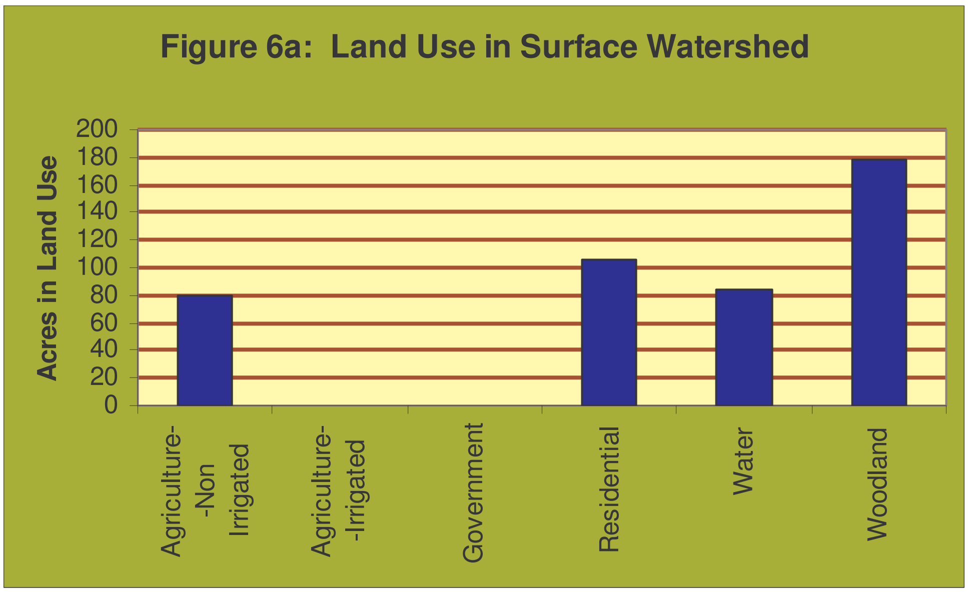
Goose Lake--Ground Watershed Land Use

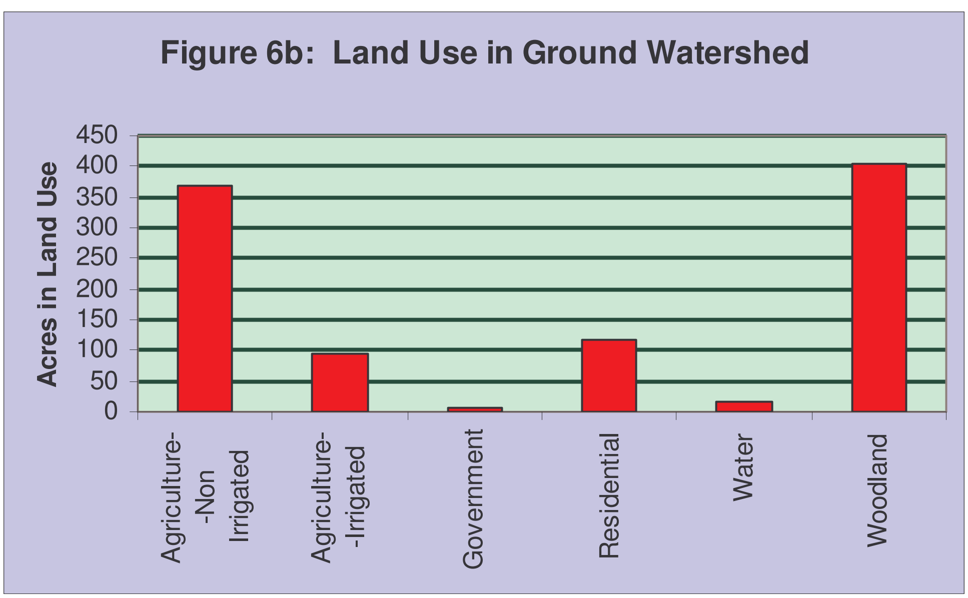


RE:2/05

Figure 5b: Land use in Goose Lake Ground Watershed

When water runs over a surface, it picks up whatever loose pollutants—sediment, chemicals, metals, exhaust gas, etc—are present on that surface and takes those items with it into the lake. Increased development around a lake tends to increase the amount of pollutants being carried into the lake, thus negatively affecting water quality. Residential development areas with lots of one-quarter acre or less may deliver as much as 2.5 pounds of phosphorus per year to the lake for each acre of development.





There are two specific kinds of land use—wetlands and shorelands--that are so important to water quality that they will be separately discussed.

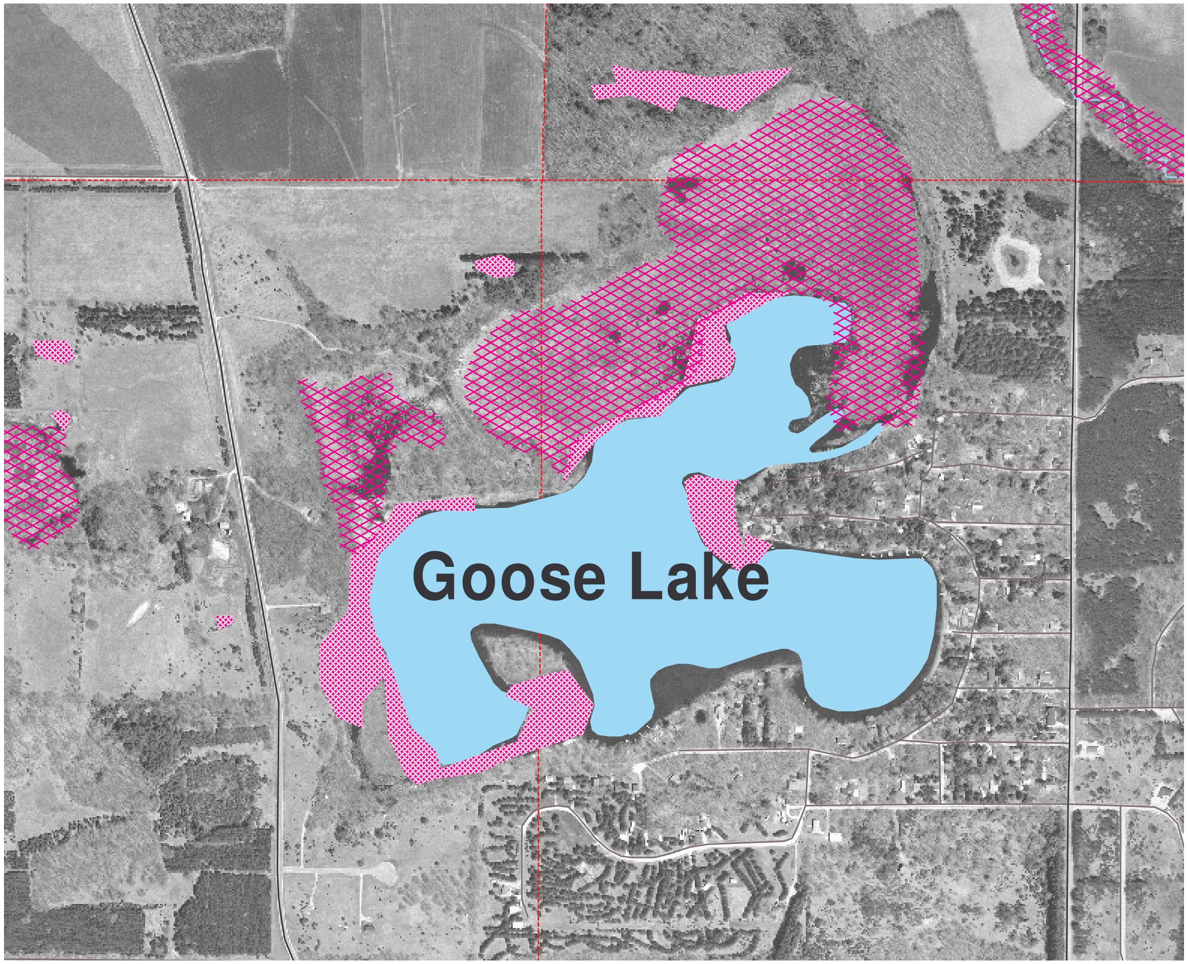
<u>WETLANDS</u>

There are extensive wetlands located around much of Goose Lake's immediate shores (Figures 5a & 5b). In the past few years, as the lake level has declined, some areas in these wetlands have become exposed and seem to be slowly drying out, unless the lake level comes back up to cover these areas. Formerly, wetlands were seen as "wasted land" that only encouraged disease-transmitting insects. Many wetlands were drained and filled in for cropping, pasturing, or even residential development. In the last few decades, however, the importance of wetlands has become evident, even as wetlands continue to decline in acreage.

Wetlands play an important role in maintaining water quality by trapping many pollutants in runoff and flood waters, thus often helping keep clean the water they connect to. They serve as buffers to catch and control what would otherwise be uncontrolled water and pollutants. Wetlands also play an essential role in the aquatic food chain (thus affecting fishery and water recreation), as well as serving as spaces for wildlife habitat, wildlife reproduction and nesting, and wildlife food.

Figure 7: former shoreland wetland area on Goose Lake now exposed

Figure 8: Wetlands Around Goose Lake



RE:5/05
revised 6/06

Known/Expected Wetlands

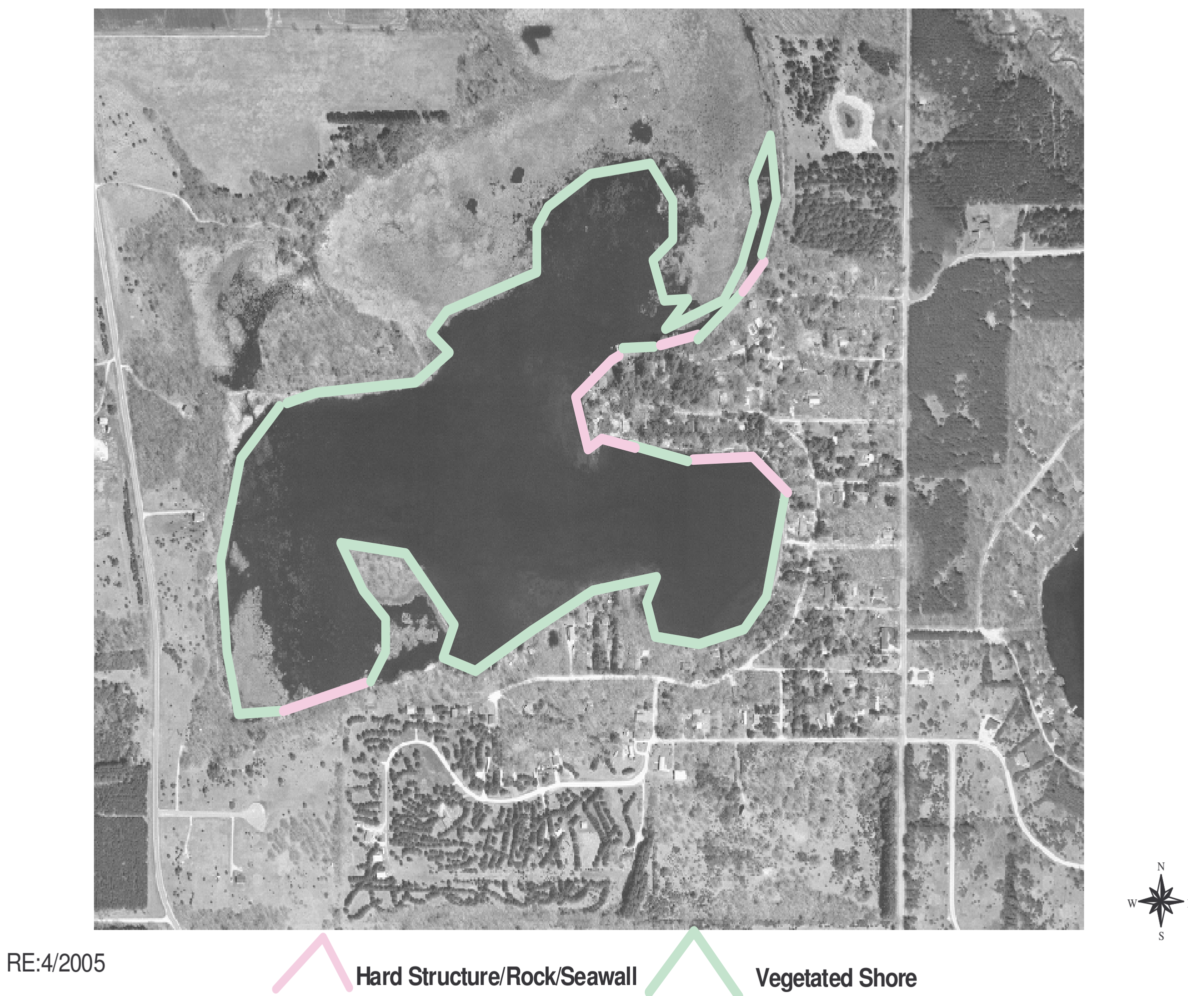
*information from Wisconsin Department of Natural Resources and Natural Resource Conservation Service

N
W E
S

SHORELANDS

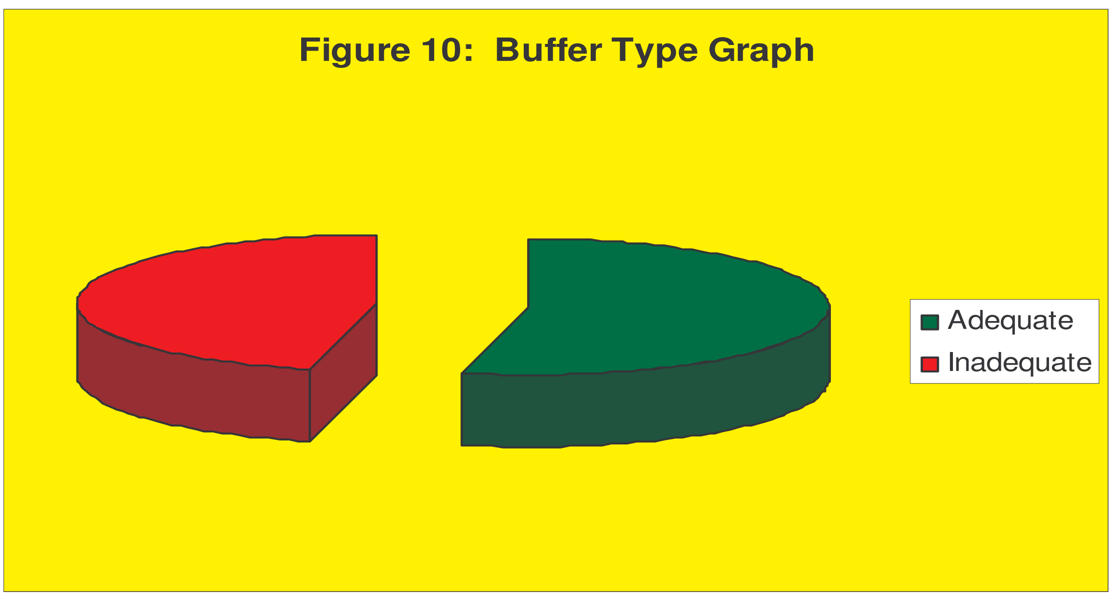
Goose Lake has a total shoreline of 2.8 miles (14784 feet). Over half of the immediate shore area is in residential. There are no residences on the northeast side of the lake, where there is an extensive wetland. Some of the area near the shore is steeply sloped. Several of the older cottages are located very close to the shore. 81.27% (12015 feet) of Goose Lake's shoreline is vegetated.

Figure 9: Shoreline of Goose Lake (2004)



Under the Adams County Shoreland Ordinance, the first 35 feet landward from the water is a "buffer." Shoreland buffers are an important part of lake protection and restoration. These buffers are simply a wide border of native plants, grasses, shrubs and trees that filter and trap soil & similar sediments, fertilizer, grass clippings, stormwater runoff and other potential pollutants, keeping them out of the lake. A 1990 study of Wisconsin shorelines revealed that a buffer of native vegetation traps 5 to 18 times more volume of potential pollutants than does a developed, traditional lawn or hard-armored shore.

The 2004 inventory included classifying areas of the Goose Lake shorelines as having "adequate" or "inadequate" buffers. An "adequate" buffer was defined as one having the first 35 feet landward covered by native vegetation. An "inadequate" buffer was anything that didn't meet the definition of "adequate buffer", including native vegetation strips less than 35 feet landward. Using these definitions, 57.35% (8479.2 feet) of Goose Lake's shoreline had an "adequate buffer", leaving 42.65% (6304.8 feet) as "inadequate." Most of the "inadequate" buffer areas were found with mowed lawns and/or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line.



Vegetated shoreland buffers help stabilize shoreline banks, thus reducing bank erosion. The plant roots give structure to the bank and also increase water infiltration and decrease runoff. A vegetated shore is especially important when shores are steep and soft, as are many of the Goose Lake shores. Figure 11 maps the adequate and inadequate buffers on Goose Lake.

Figure 11: Buffer on Goose Lake (2004)

RE:4/2005 **Pink = Inadequate Buffer** **Blue = Adequate Buffer**

Lakeside buffers also serve as important habitat. Lake edges usually contain aquatic and wetland plants, grading into drier groundcover, then shrubs and trees as one moves inland towards drier land. Buffers provide habitat for many species of water-dependent wildlife, including furbearers, reptiles, birds and insects. Many wildlife species, including birds, small mammals, fish & turtles breed, nest, forage and/or perch in shore buffer areas. Further, 80% of the endangered and threatened species listed spend part of their life in this near-lake buffer area. (Wagner et al, 2006)

Figure 12a: Example of Inadequate Buffer

Figure 12b: Example of Adequate Buffer

When the natural shoreline is replaced by mowed turf-grass lawns, rock, wooden walls or similar installments, bird and animal life, land-based insects, and aquatic insects that hatch or winter on natural shore are negatively impacted. For example, on many Adams County lakes, the non-native aquatic plant, Eurasian Watermilfoil has invaded. There is a weevil native to Wisconsin that weakens Eurasian Watermilfoil by burrowing into and developing within its stems, but that weevil depends on a native-plant shore to overwinter. If the shore is instead covered by rock, seawall or traditional lawn, these weevils will be unavailable for the lake to use as Eurasian Watermilfoil control.

The filtering process and bank stabilization that buffers provide help improve a lake's water quality, including water clarity. Studies in Minnesota, Maine and Michigan have shown that waterfront property value increases for every foot the water clarity of a lake increases. (Krysel et al, 2003).

Natural shoreland buffers serve important cultural functions. They enhance the lake's aesethics. Studies have shown that aeshetics rank high as one of the reasons people visit or live on lakes. Shore buffers can provide visual & audio privacy screens for homeowners from other neighbors and/or lake users.

Adequate buffers on Goose Lake could be easily installed on most of the lake by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or—if something more controlled or aesthetically pleasing was desired—by planting native seedlings sufficient to fill in the first 35 feet.

The boat ramp and small beach area are located on the east side of the lake. They are at the end of fairly steep, paved area that leaves them vulnerable to both water and wind erosion. A rainstorm in 2006 washed out some sections of the boat ramp. Plans are to repair the boat ramp in the next two years to make the boat ramp safe and should to protect this area from further erosion. If appropriately done, this would also keep some soil particles from ending up in the lake.

Figure 13: Example of Vegetated Shore on Goose Lake

WATER QUALITY

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on 20 lakes in Adams County with public access. Goose Lake was one of these lakes. Part of the information was gained from periodic water sampling done by Adams County LWCD. Historic information about water testing on Goose Lake was also obtained from the WDNR (1992).

Phosphorus

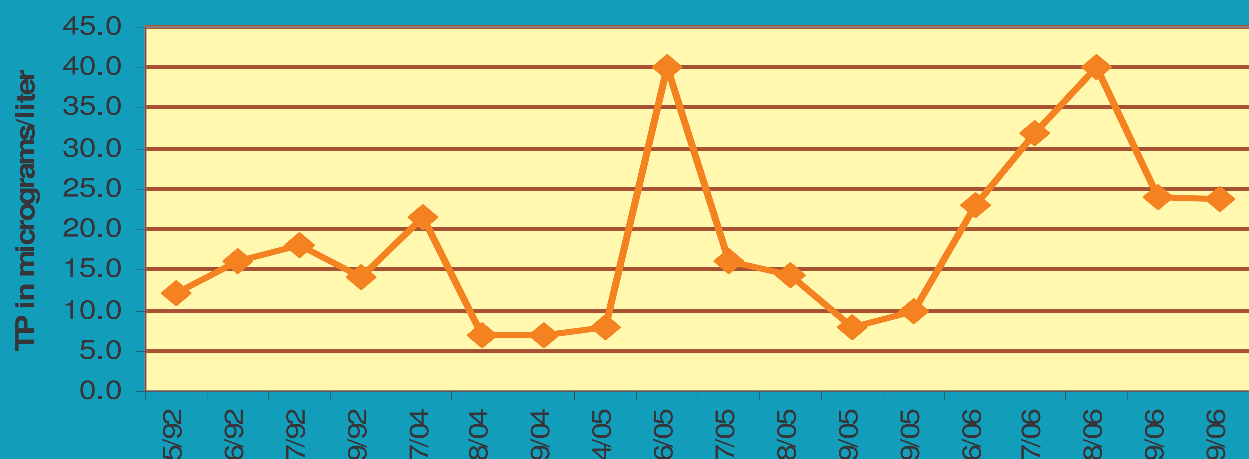
Most lakes in Wisconsin, including Goose Lake, are phosphorus-limited lakes: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other quality aspects. One pound of phosphorus can produce as much as 500 pounds of algae.

Phosphorus is not an element that occurs in high concentration naturally, so any lake that has significant phosphorus readings must have gotten that phosphorus from outside the lake or from internal loading. Some phosphorus is deposited onto the lake from atmospheric deposition, especially from soil or other particles in the air carrying phosphorus. A lake that includes a flooded wetland area may have a significant amount of phosphorus being released during the flushing of the wetland area. Phosphorus may accumulate in sediments from dying animals, dying aquatic plants and dying algae. If the bottom of the lake becomes anoxic (oxygen-depleted) or hypoxic (low oxygen), chemical reactions may cause phosphorus to be released into the water column.

Although there are several forms of phosphorus in water, the total phosphorus (TP) concentration is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For a natural lake like Goose Lake, a total phosphorus concentration below 25 micrograms/liter tends to reduce nuisance algal blooms. Goose Lake's growing season (June-September) water column average total phosphorus level of 16.85 micrograms/liter is below that level. If nuisance algal blooms have occur on Goose Lake, as they have recently, they were perhaps aggravated by the hot still weather for the summers of 2006 and 2007.

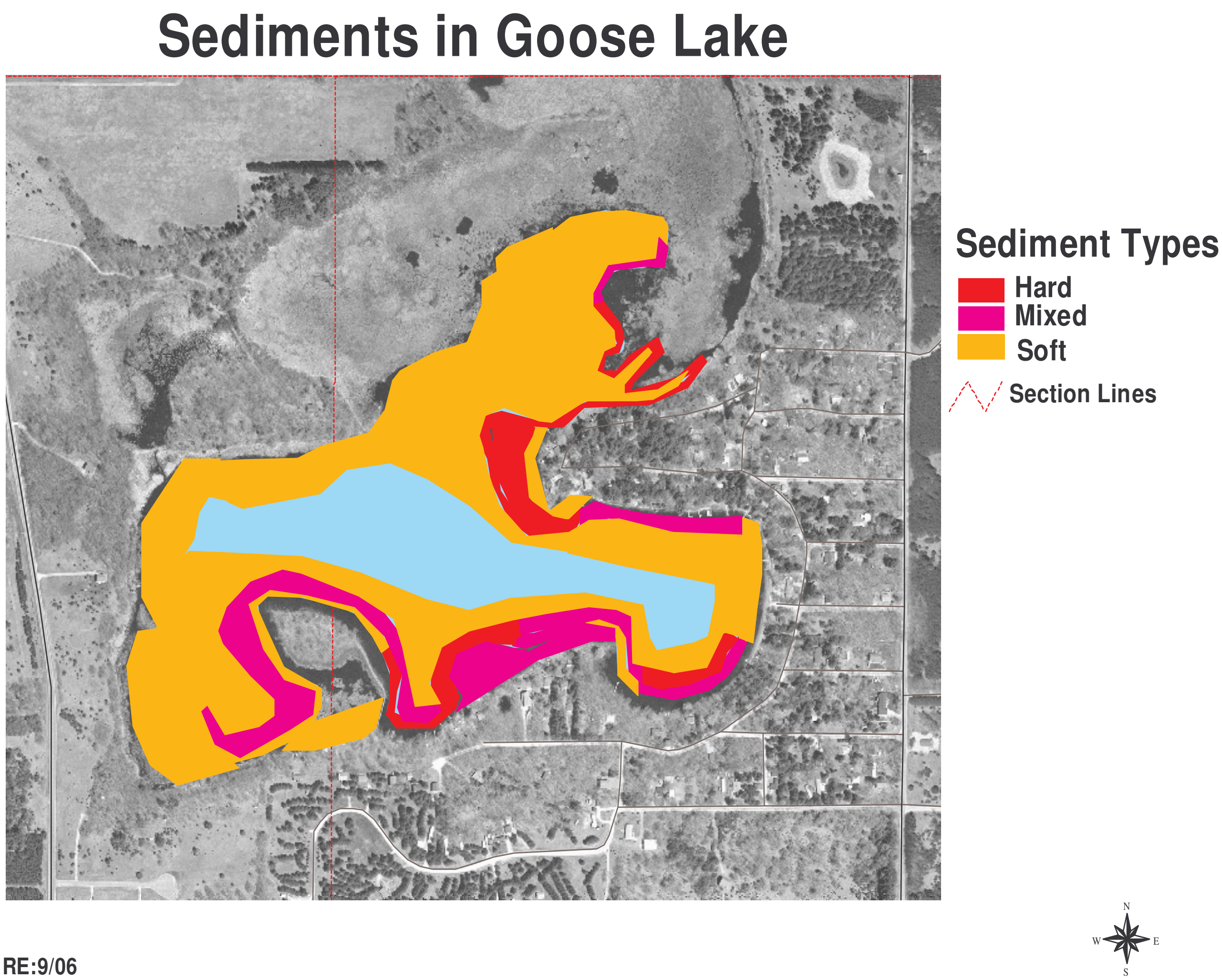
Since the limiting factor in Goose Lake is phosphorus, measuring the phosphorus in a lake system provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. The 2004-2006 epilimnetic (surface) summer average phosphorus concentration in Goose Lake was 16.85 micrograms/liter. As the graph below (Figure 14) shows, eplimnetic total phosphorus levels stayed fairly steady until the summers of 2005 and 2006, when the weather was very hot and still for several weeks. The average of 16.85 micrograms/liter is below the 25 micrograms/liter average for natural lakes in Wisconsin. This concentration suggests that Goose Lake is likely to have few nuisance algal blooms. This places Goose Lake in the "good" level for phosphorus.

Figure 14: Eplimnetic Phosphorus in Goose Lake



Groundwater testing of various wells around Goose Lake was done by Adams County LWCD and included a test one year (2006) for total phosphorus levels in the groundwater coming into the lake. The average TP level in the wells tested was 14 micrograms/liter, somewhat lower than the lake surface water results. This phosphorus may also seep into Goose Lake, although if the level remains that low, it wouldn't be a significant contributor of phosphorus to the lake.

Figure 15: Sediment Distribution in Goose Lake, 2006



Land use plays a major role in phosphorus loading. A key component of the computer models used is the phosphorus budget, that is, the estimated amount of phosphorus delivered to the lake from each land use type annually. The land uses that contribute the most phosphorus are non-irrigated agriculture and irrigated agriculture. Using the current land use data, as well as phosphorus readings from 2004 through 2006 water sampling, a phosphorus loading prediction model was run for Goose Lake. The current results are shown in Figure 16:

Figure 16: Current Phosphorus Loading by Land Use

MOST LIKELY PHOSPHORUS LOADING		
BY LAND USE		lbs
	%	current
Agriculture--Non Irrigated	22.2%	28.60
Residential	18.7%	24.20
Lake Surface	8.9%	11.00
Woodland	6.3%	8.80
Septic	8.6%	10.89
Groundshed	35.3%	44.00
total in pounds/year	100.0%	127.49

Phosphorus deposits such as that from flooded wetlands or from atmospheric deposition cannot be controlled by humans. However, some phosphorus (and other nutrient) input can be decreased or increased by changes in human land use patterns. Practices such as shoreland buffer restoration; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Circumstances such as increased impervious surface, lawns mowed to water's edge, disturbance of shore areas, improperly-functioning septic systems and removal of native vegetation can greatly increase the volume and content of runoff—and thus increase the volume of phosphorus entering the lake. Many of these practices can also increase the concentration of phosphorus entering the lake, by runoff or other methods of entry.

The models were run using not only the current known phosphorus readings in the lake, but also representing decreases or increases of human-controlled phosphorus input by 10%, 25%, and 50%. The figures may not seem like much---until you calculate that one pound of phosphorus can result in up to 500 pounds of algae. A 10% reduction in these three areas could result in 10.77 lbs/year and up to 5385 pounds less of algae per year!

LAND USE	lbs			
	current	-10%	-25%	-50%
Agriculture--Non Irrigated	28.60	25.74	21.45	14.30
Residential	24.20	21.78	18.15	12.10
Lake Surface	11.00	11.00	11.00	11.00
Woodland	8.80	8.80	8.80	8.80
Septic	10.89	9.80	8.17	5.45
Groundshed	44.00	39.60	33.00	22.00
total in pounds/year	127.49	116.72	100.57	73.65

Looking at this issue in terms of how much phosphorus readings in the lake might change, based on the computer modeling, in-lake perhaps makes it clearer. Figure 18 shows that the effect of 10% and 25% decrease to human-impacted phosphorus within the lake.

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve Goose Lake water quality by .8 to 4 micrograms of phosphorus/liter; a 25% reduction would save 2 to 10 micrograms/liter (see Figure 18). This kind of reduction would decrease the likelihood of algal blooms and might assist in reducing aquatic plant density. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Goose Lake's health for future generations.

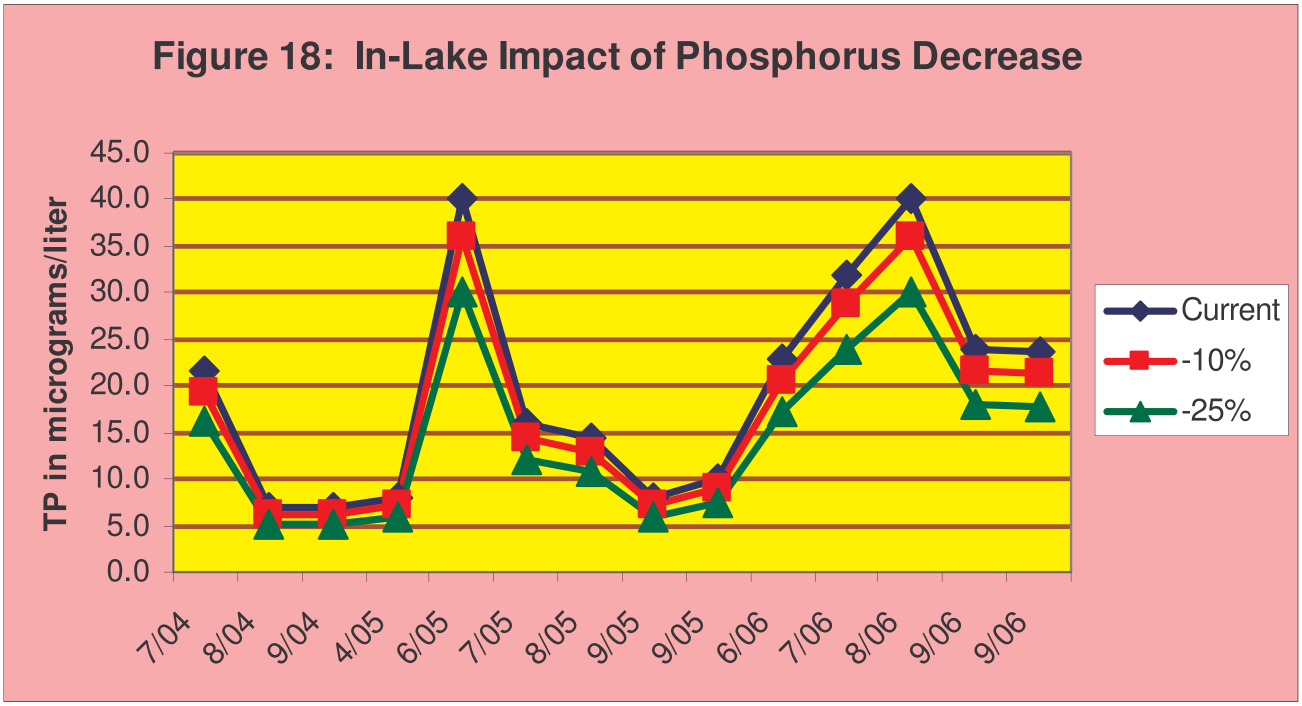


Figure 19: Photo of a Lake with Algal Bloom

Water Clarity

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Goose Lake in 2004-2006 was 7.1 feet. This is good water clarity, putting Goose Lake into the "mesotrophic" category for water clarity. However, as can be seen in Figure 20, the growing season Secchi disk readings are generally getting less

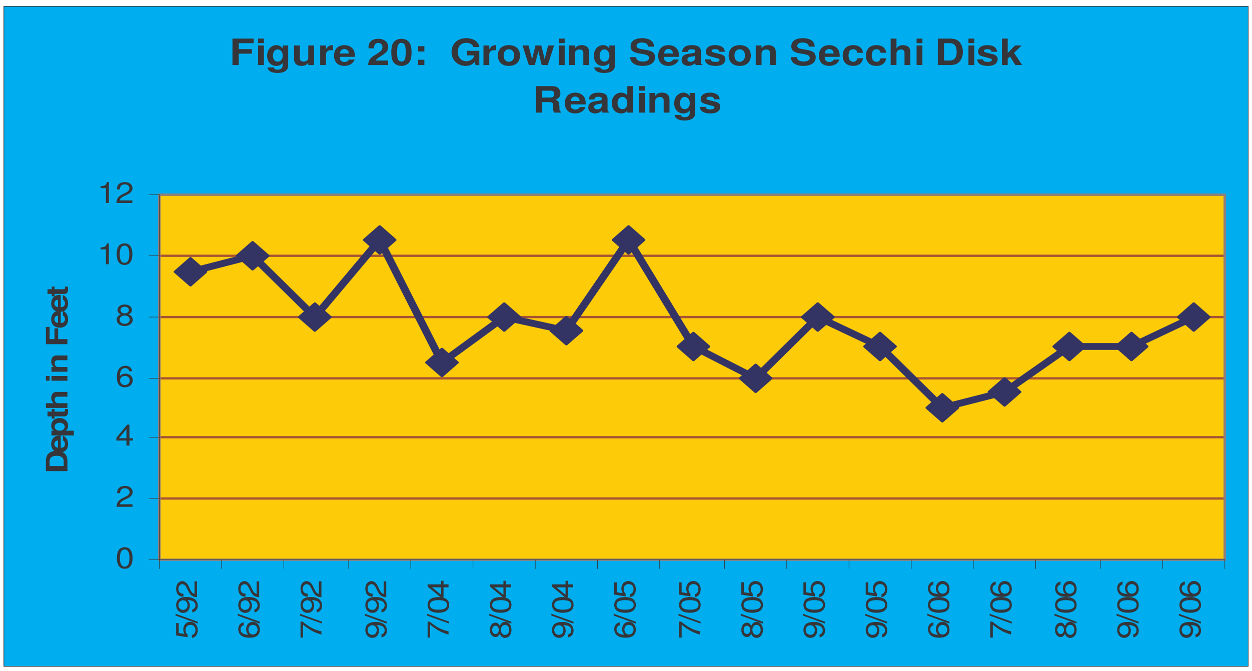
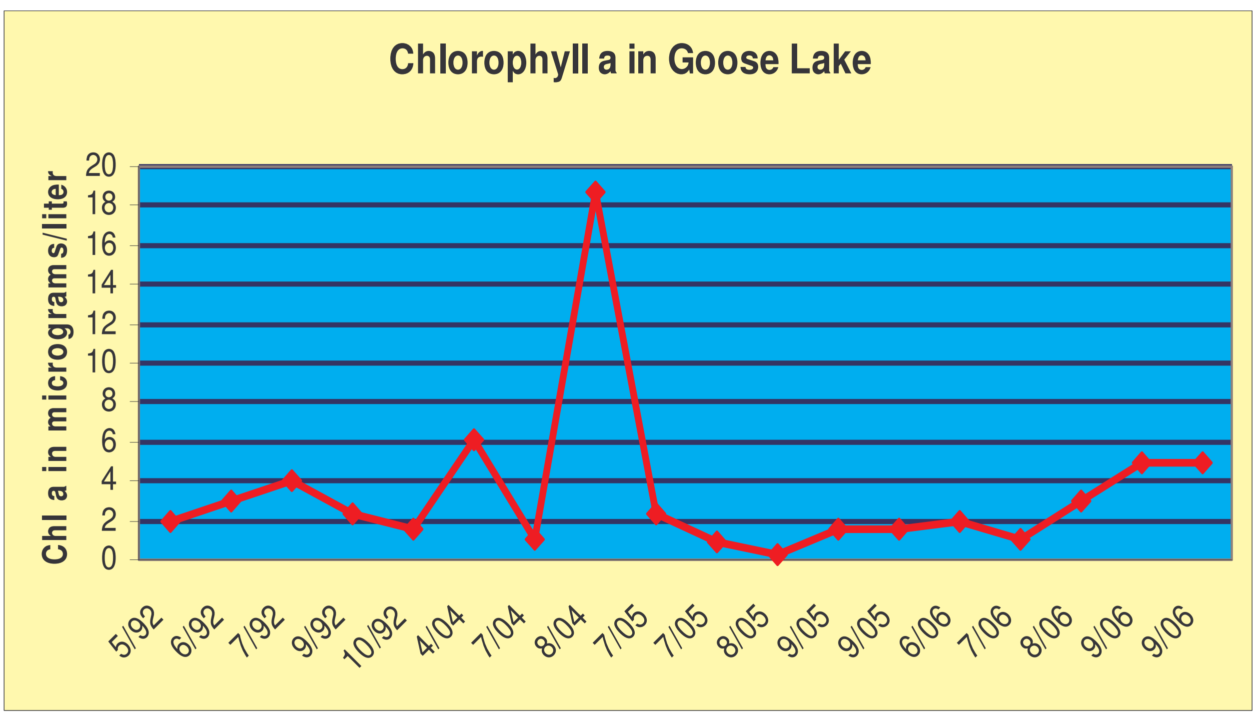


Figure 21: Photo of Testing Water Clarity with Secchi Disk

Chlorophyll a

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. Studies have shown that the amount of chlorophyll a in lake water depends greatly on the amount of algae present; therefore, chlorophyll-a levels are commonly used as a water quality indicator. Chlorophyll-a readings were taken during the growing season in 1992 by the WDNR. At that time the growing season average for chlorophyll-a was 2.84 micrograms/liter. The 2004-2006 summer (June-September) average chlorophyll concentration in Goose Lake was 5.63 micrograms/liter. This low algae concentration places Goose Lake at the "mesotrophic" level for chlorophyll a results.

Figure 22: Summer Chlorophyll-a Averages

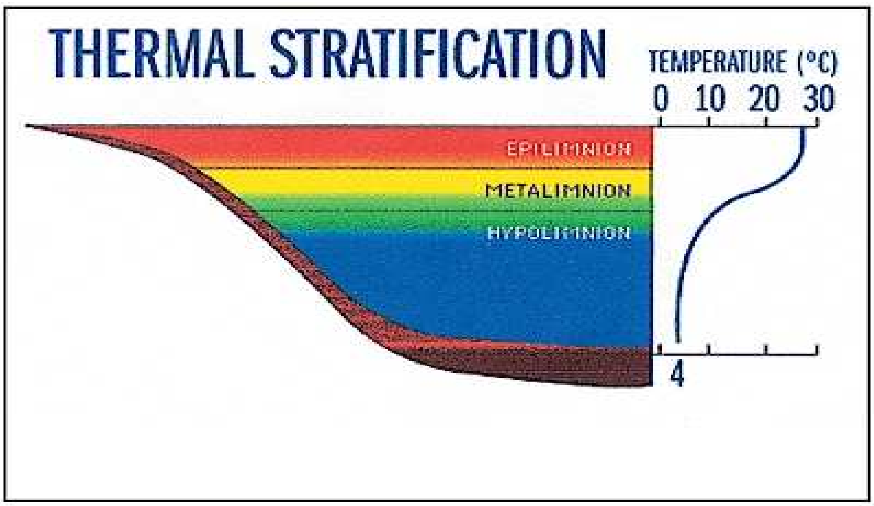


Dissolved Oxygen

Oxygen dissolved in the water is essential to all aerobic aquatic organisms. The oxygen in a lake comes from the atmosphere and from the process of photosynthesis. Aquatic plants and algae consume carbon dioxide and respirate oxygen back into the lake water. The distribution of oxygen within a lake is affected by many factors, including water circulation, water stratification, winds or storms, air temperature; water temperature, nutrient availability, and the density and location of algae and/or aquatic plants.

Oxygen consumption in the sediment and the water just above it (hypolimnion) is more sensitive that those in the two upper layers of water (metalimnion and epilimnion) because the bottom consumption is less likely to be balanced by the circulation and photosynthesis output available to the upper layers.

Figure 23: Lake Stratification Layers



Goose Lake probably doesn't stratify due to its shallow depths, but its bottom water still had low oxygen levels in two of the three years tested by the Adams County LWCD. Low oxygen during the summer in the bottom waters of a lake occurs naturally as oxygen in the bottom layer is consumed, but not replenished. It is common that as the summer progresses, the oxygen concentration of the bottom waters decreases. In Goose Lake, there were hypoxic periods in the depths over 15 feet during the summers of 2004 and 2005. In July 2004, dissolved oxygen level at the bottom was only .4 mg/l. It rose to 2.9 mg/l by August. In 2005, dissolved oxygen concentration at the bottom was 1.6 mg/l. This pattern was not present in 2006 when oxygen levels at all depths were over 5 mg/l (the minimum level for most fish survival).

The charts (Figures 24a, b, c) below show the annual (2004-2006) variations in dissolved oxygen levels in milligrams/liter, depth in feet and months of the year:

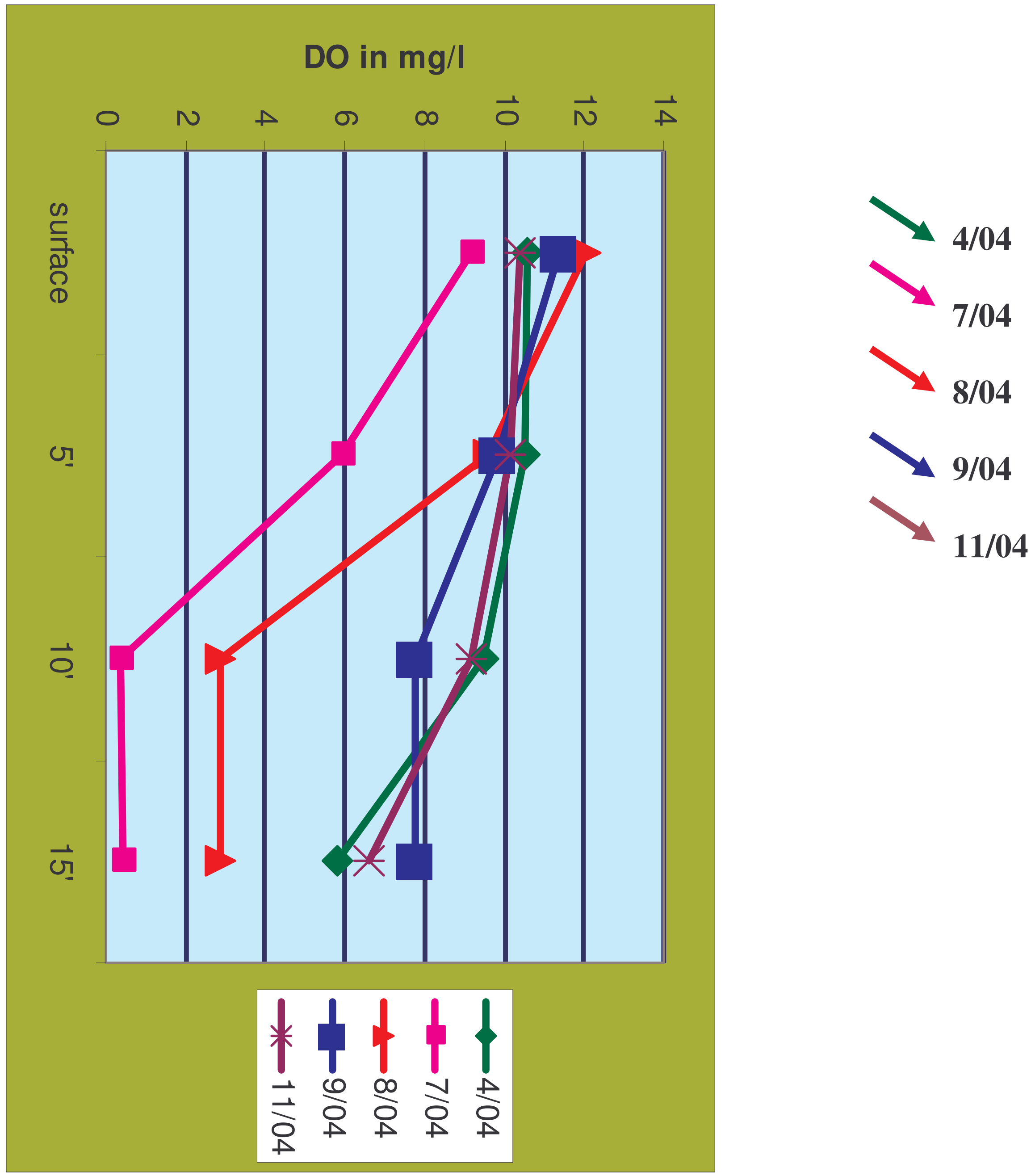
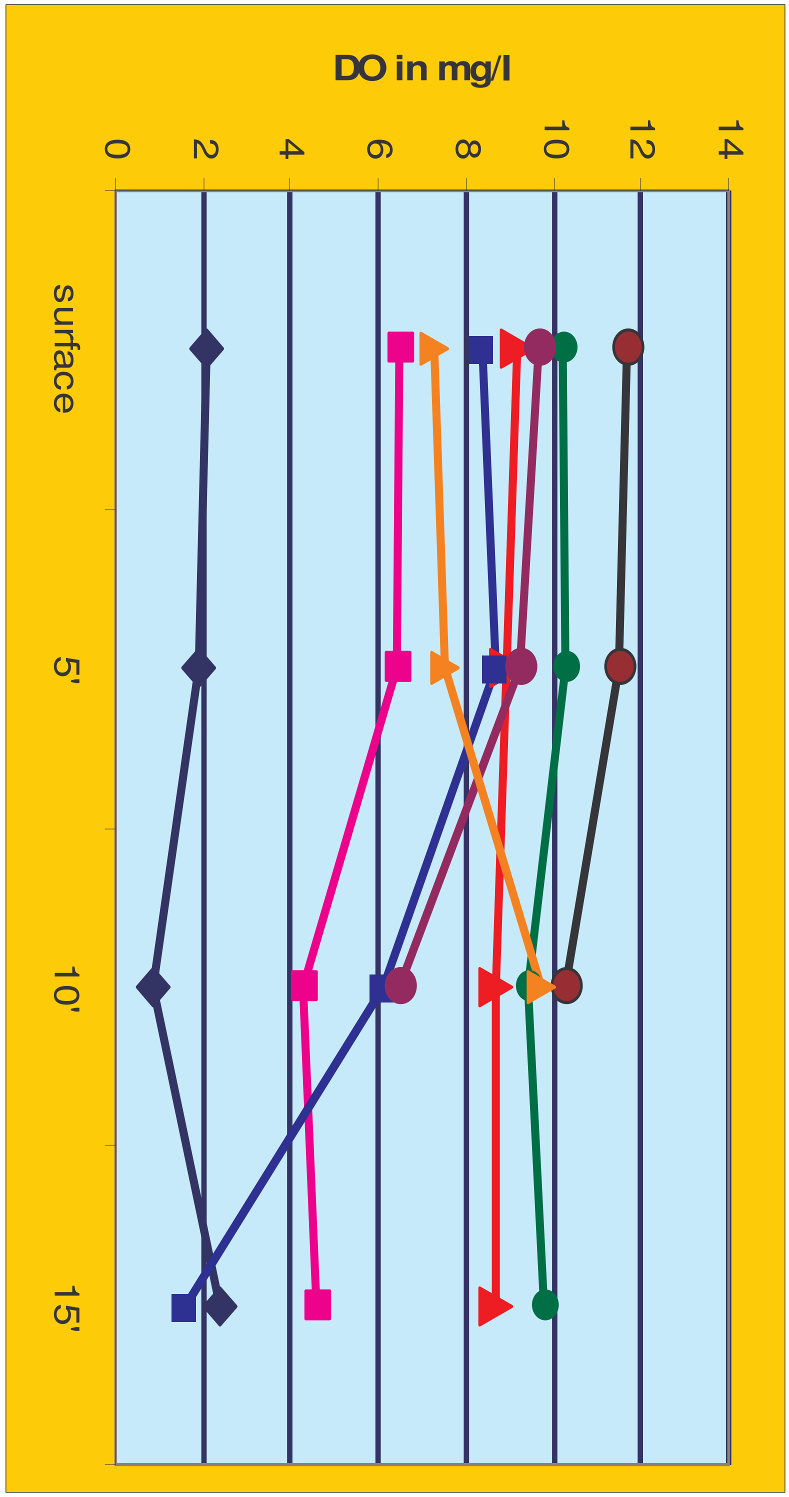


Figure 24b: Dissolved Oxygen Levels During 2005 Water Testing in milligrams/liter



2/05

4/05

6/05

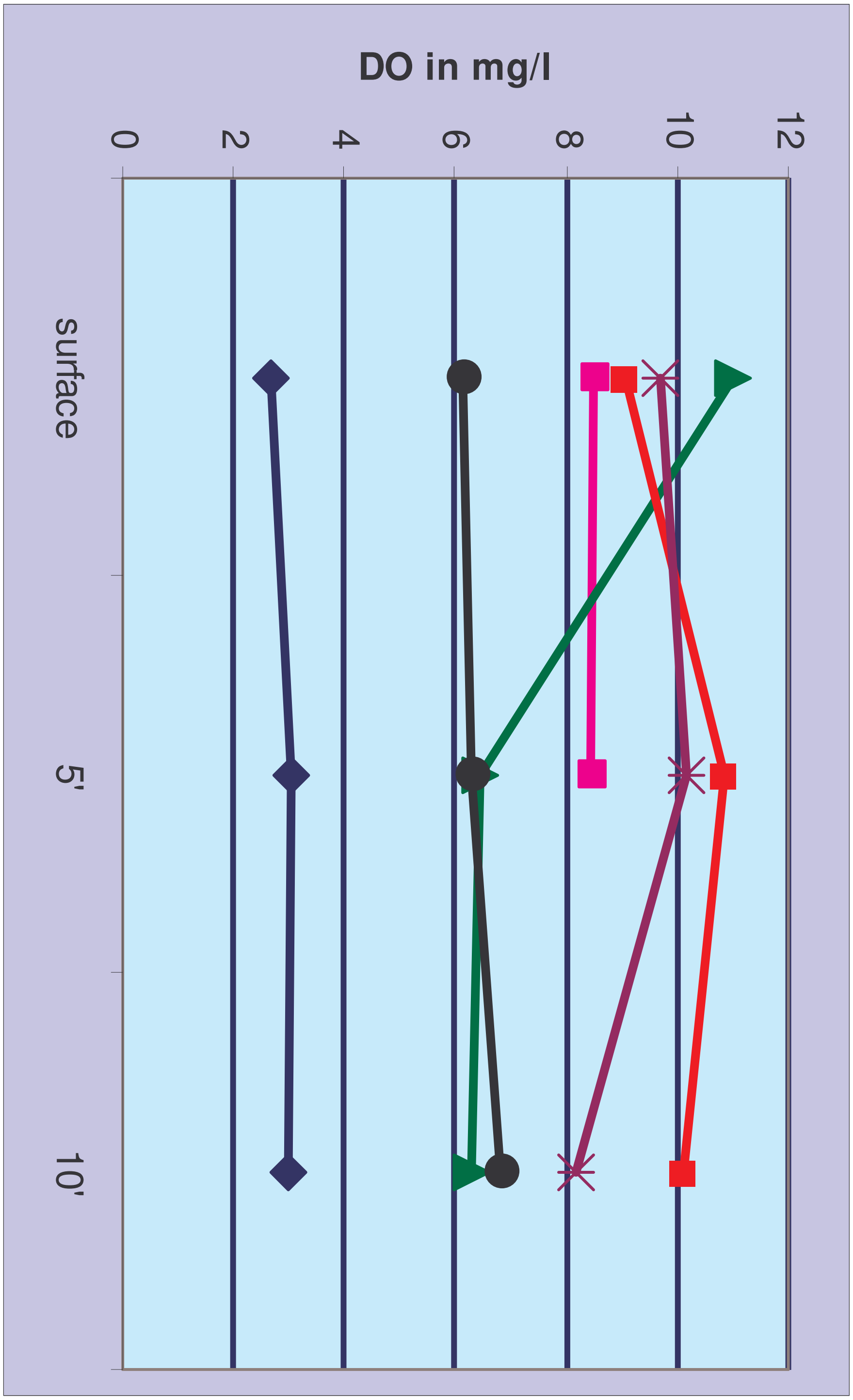
7/05

8/05

9/05

11/05

Figure 24c: Dissolved Oxygen Levels During 2006 Water Testing in milligrams/liter*



4/06

6/06

7/06

8/06

9/06

9/06

*no 15’ depth due to very low water levels

Human activity can aggravate the development of low oxygen (hypoxic) or no oxygen (anoxic) in the bottom waters. For example, the addition of phosphorus usually leads to an increase in the growth of algae and aquatic plants—both of which consume oxygen during their photosynthesis. It has also been hypothesized that hypoxia or anoxia can be affected by climate changes, such as a longer and/or warmer summer, low lake levels, and changes in water temperature due to cover (i.e., shore vegetation) being removed.

The development of hypoxia or anoxia can have negative effects. The first effect usually noticed by human is fish kills. Fish kills result when fish species that need cold oxygen-rich water to survive can't find it in the lake anymore or when some of their invertebrate food (such as mayfly nymphs) is gone due to low oxygen levels. Another noticeable effect can be an increase in the frequency and distribution of algal blooms. In some instances, anoxia can lead to blooms of toxic algae and the production of water-borne toxins that can harm humans and wildlife. Anoxia sometimes also leads to increased phosphorus cycling, undesirable water taste or odor levels, and interference with recreational uses such as swimming, boating and fishing.

As noted above, summer hypoxia or anoxia can result in phosphorus being released into the upper water column and being available for algal blooms and increased aquatic plant growth. The results from 2004 through 2006 (the only years for which data is available) don't show that summer hypoxia/anoxia in the lower depths is always a problem in Goose Lake, but it did show up in two of the three years.

The data from 2004-2006 (see Figures 24a, b, c) shows there is potential for phosphorus loading from the lower depths (hypolimnion) during the summer months in Goose Lake if the hypoxia/anoxia continues. Dissolved oxygen needs to be monitored during the late summer months in the lower depths on Goose Lake to determine whether hypoxia/anoxia is a frequently-occurring condition that may need to be addressed by management practices.

Goose Lake does have an aerator system that it runs through the winter, as needed, to maintain dissolved oxygen levels for fish and prevent winter fishkill. One option would be to run the aerators through some times in the summer, although since the lesser depths have sufficient oxygen for the fish, that may be unnecessary.

Water Hardness, Alkalinity and pH

Testing done by Adams County LWCD on Goose Lake included annual testing for water alkalinity and water hardness. Hardness and alkalinity levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water & these materials.

Level of Hardness	Mg/l CaCO3
SOFT	0-60
MODERATELY HARD	61-120
HARD	121-180
VERY HARD	>180

Figure 25: Levels of Hardness in Mg/l of Calcium Carbonate

One method of evaluating hardness is to test the water for the amount of calcium carbonate ($CaCO_3$) it contains. The surface water of all of the public access lakes in Adams County is moderately hard to very hard. Goose Lake's surface water averages 90.67 mg/l (hard) of CaC03. The ground water of Goose Lake watershed is harder than the surface water. In 2005 and 2006, random samples were also taken of wells around Goose Lake to measure the hardness of the water coming into the lake through groundwater. Hardness in the groundwater ranged from 184 (very hard) to 332 (very hard). The hardness in both surface and groundwater is likely due to the underlying bedrock in Adams County, which is mostly sandstone with pockets of dolomite and shale.

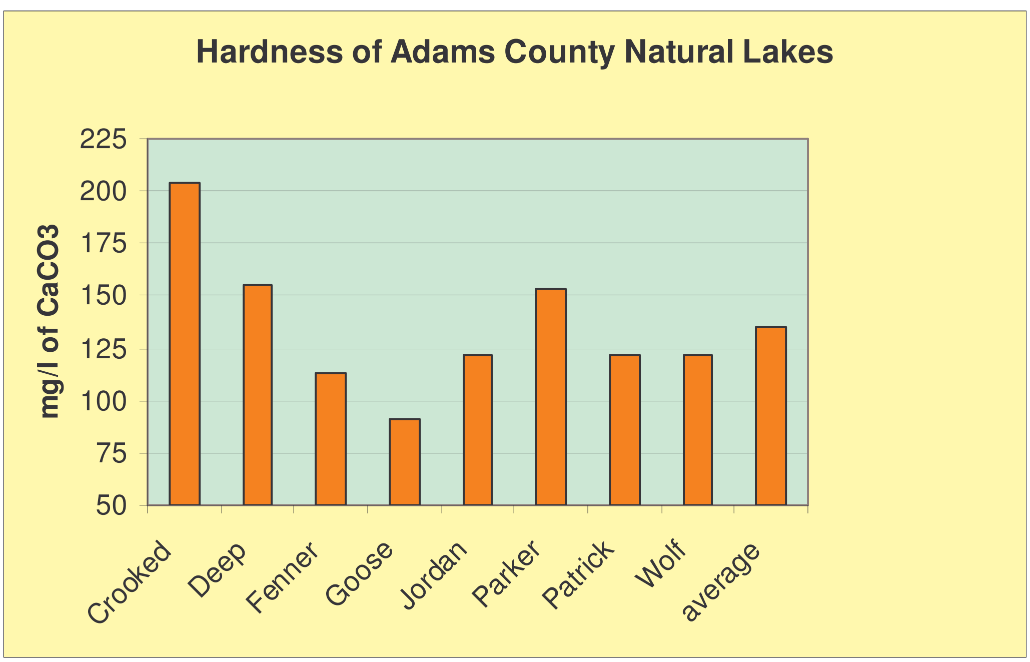


Figure 26:

As the graph (Figure 26) shows, Goose Lake surface water testing results showed "hard" water, with a lower level than the average for Adam County's natural lakes (135 mg/l of Calcium Carbonate). Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

Alkalinity is important in a lake to buffer the effects of acidification from the atmosphere. "Acid rain" has long been a problem with lakes that had low alkalinity level and high potential sources of acid deposition.

Acid Rain Sensitivity	ueq/l CaCO3
High	0-39
Moderate	49-199
Low	200-499
Not Sensitive	>500

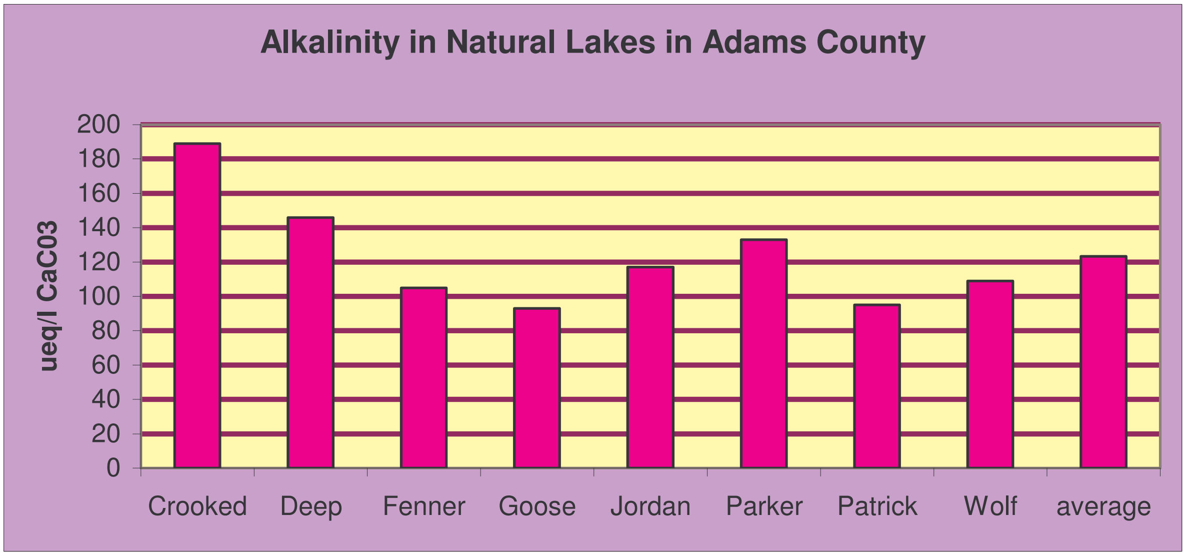
Figure 27: Acid Rain Sensitivity

Well water testing results ranged from 132ueq/l to 220 ueq/l in alkalinity, with an average of 179.1 ueq/l. That is considerably higher than the surface water results of average of 92 ueq/l. Goose Lake's potential sensitivity to acid rain is moderate, but luckily for Adams County, the acid deposition rate is very low, probably due to the little industrialization in the county.

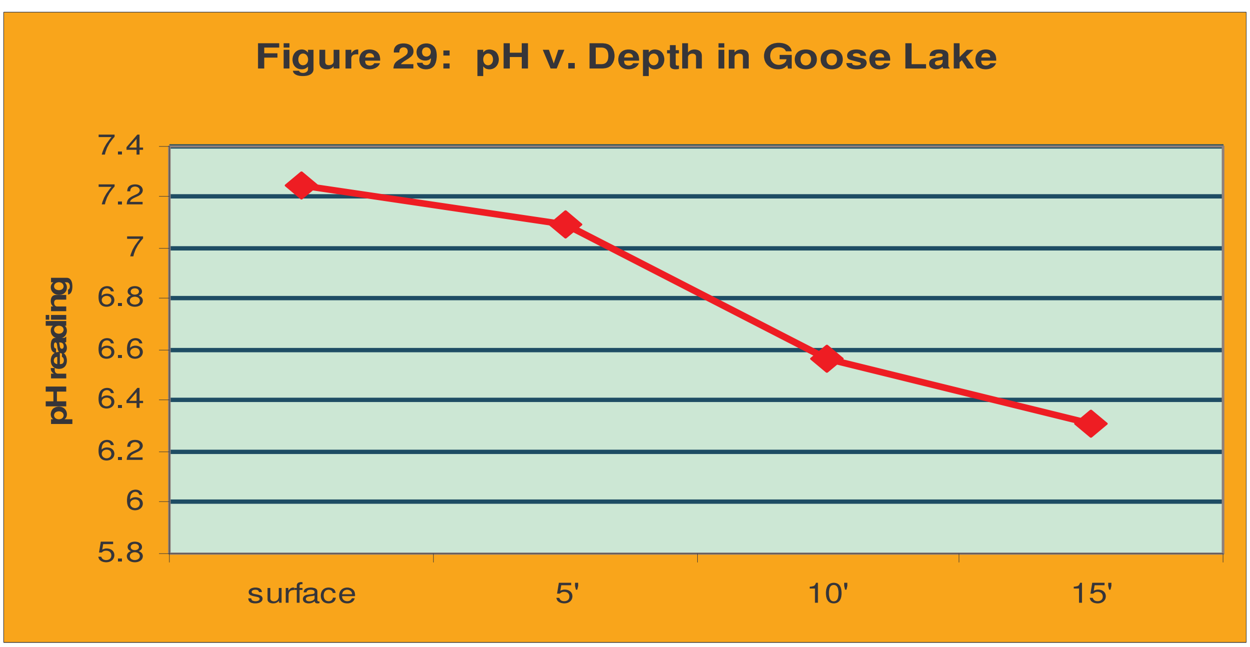
Alkalinity also affects the pH level of lake water. The acidity level of a lake's water regulates the solubility of many minerals. A pH level of 7 is neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid bog lakes to 8.4 in hard water, marl lakes.

Some of the minerals that become available under low pH, especially the metals aluminum, zinc and mercury, can inhibit fish reproduction and/or survival. Even what seems like a small variance in pH can have large effects because the pH scale is set up so that every 1.0 unit change increases acidity tenfold, i.e., water with a pH of 7 is 10 times more acid than water with pH of 8. Mercury and aluminum are not only toxic to many kinds of wildlife; they can also be toxic to humans, especially those that eat tainted fish.

Figure 28: Graph of Natural Lake Alkalinity



The testing occurring from 2004-2006 also included regular monitoring of the pH at several depths in Goose Lake. As is common in the lakes in Adams County, Goose Lake has pH levels starting at just under neutral (6.31) at the bottom depth and increasing in alkalinity as the depth gets less, until the surface water pH averages 7.25. A lake's pH level is important for the release of potentially harmful substances and also affects plant growth, fish reproduction and survival. Most plants grow best at pH levels between 5.5 and 8.



More importantly for many lakes, fish reproduction and survival are very sensitive to pH levels. The chart below indicates the effect of pH levels under 6.5 on fish (Figure 30):

Figure 30: Effects of pH Levels on Fish

Water pH	Effects
6.5	walleye spawning inhibited
5.8	lake trout spawning inhibited
5.5	smallmouth bass disappear
5.2	walleye & lake trout disappear
5	spawning inhibited in most fish
4.7	Northern pike, sucker, bullhead, pumpkinseed, sunfish & rock bass disappear
4.5	perch spawning inhibited
3.5	perch disappear
3	toxic to all fish

A lake with a neutral or slightly alkaline pH like Goose Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at Goose Lake.

Figure 31: Abundant Fish in Goose Lake: Bluegill

Other Water Quality Testing Results

CALCIUM and MAGNESIUM: Calcium is required by all higher plants and some microscopic lifeforms. Magnesium is needed by chlorophyllic plants and by algae, fungi and bacteria. Both calcium and magnesium are important contributors to the hardness of a lake's waters. Magnesium elevated above 125 mg/l may have a laxative effect on some humans. Otherwise, no health hazards to humans and wildlife are known from these elements. The average Calcium level in Goose Lake's water during the testing period was 22.31 mg/l. The average Magnesium level was 11.72 mg/l. Both of these are low-level readings.

CHLORIDE: Chloride does not affect plant and algae growth and is not known to be harmful to humans. It isn't common in most Wisconsin soils and rocks, so is usually found only in very low levels in Wisconsin lakes. However, the presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus a possible indication that too many nutrients are entering the lake. Goose Lake chloride levels found during the testing period averaged 2.13 mg/l, well below the natural level of 3 mg/l of chloride in this area of Wisconsin.

NITROGEN: Nitrogen is necessary for plant and algae growth. A lake receives nitrogen in various forms, including nitrate, nitrite, organic, and ammonium. In Wisconsin, the amount of nitrogen in a lake's water often corresponds to the local land use. Although some nitrogen will enter a lake through rainfall from the atmosphere, that coming from land use tends to be in higher concentrations in larger amounts, coming from fertilizers, animal and human wastes, decomposing organic matter, and surface runoff. For example, the growth level of the exotic aquatic plant, Eurasian Watermilfoil (*Myriophyllum spicatum*) has been correlated with fertilization of lake sediment by nitrogen-rich spring runoff.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 mg/l in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Goose Lake combination nitrogen levels from 2004 to 2006 did rise to .61 mg/l, about twice the .3 mg/l predictive level for algal blooms. Given appropriate conditions, Goose Lake might suffer nitrogen-related algal blooms.

SODIUM AND POTASSIUM: These elements occur naturally only in low levels in Wisconsin waters and soils. Their presence may indicate human-caused pollution. Sodium is found with chloride in many road salts and fertilizers and is also found in human and animal waste. Potassium is found in many fertilizers and also found in animal waste. Increasing levels or one or both of these elements can indicate possible contamination from damaging pollutants. High levels of sodium have also been found to influence the development of a large population of cyanobacteria, some of which can be toxic to animals and humans. Both sodium and potassium levels in Goose Lake are low: the average sodium level was 1.65 mg/l; the average potassium reading was .58 mg/l.

SULFATE: In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate (H2S), which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of H2S, sulfate levels of 10 mg/l are best. A health advisory kicks in at 30 mg/l. Goose Lake sulfate levels averaged 5.48 mg/l during the testing period, far below either level.

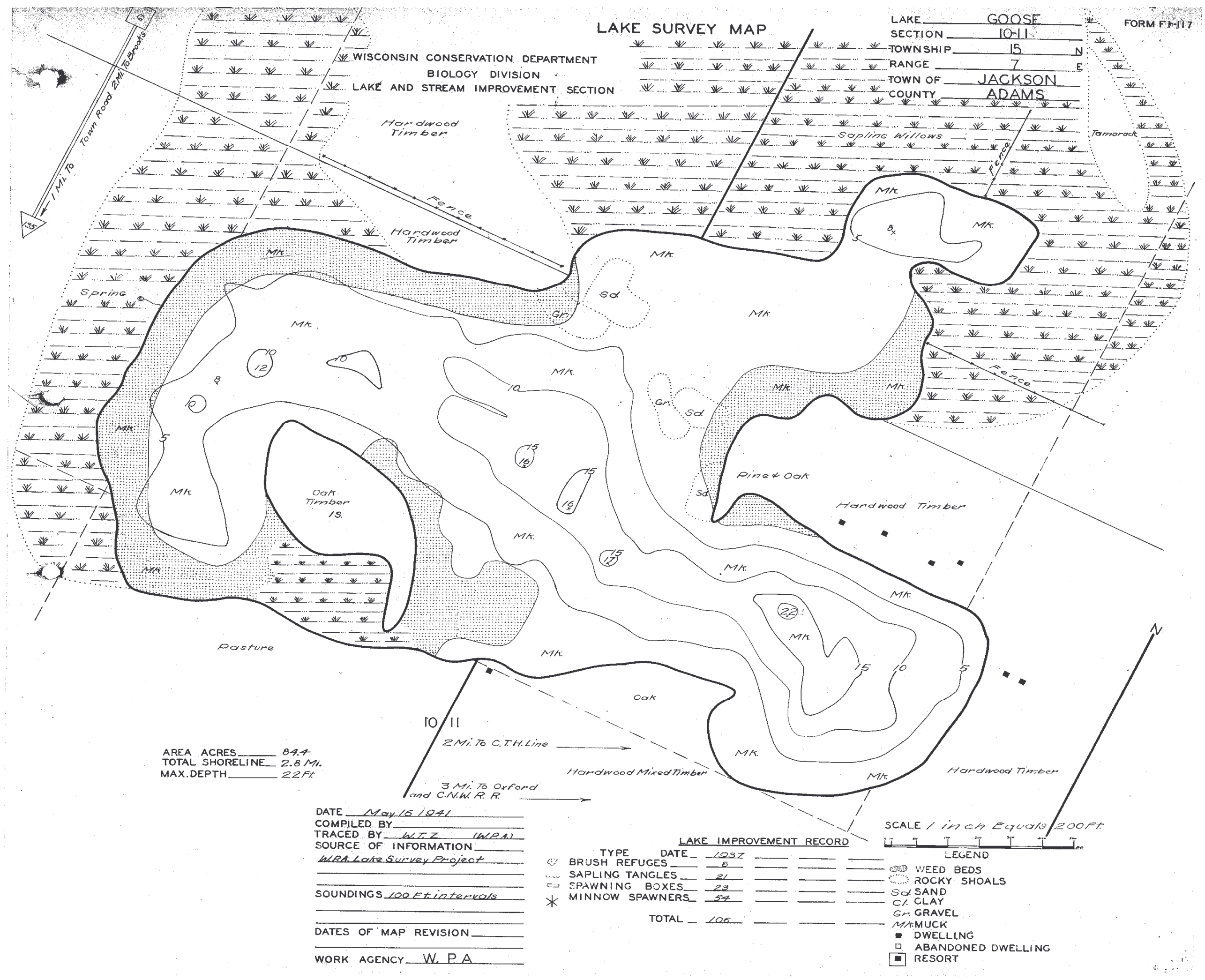
TURBIDITY: Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Goose Lake's waters were 2.01 NTU in 2004, 1.95 NTU in 2005, and 1.79 NTU in 2006—all very low levels.

Figure 32: Examples of Very Turbid Water

HYDROLOGIC BUDGET

Goose Lake has a surface area of 84.4 acres. The only bathymetric (depth) map available is one done in 1941 by the WDNR. It is difficult to tell how accurate that map is currently. The current maximum depth is 18 feet and the mean depth is 9 feet.

Figure 33: Goose Lake Bathymetric Map

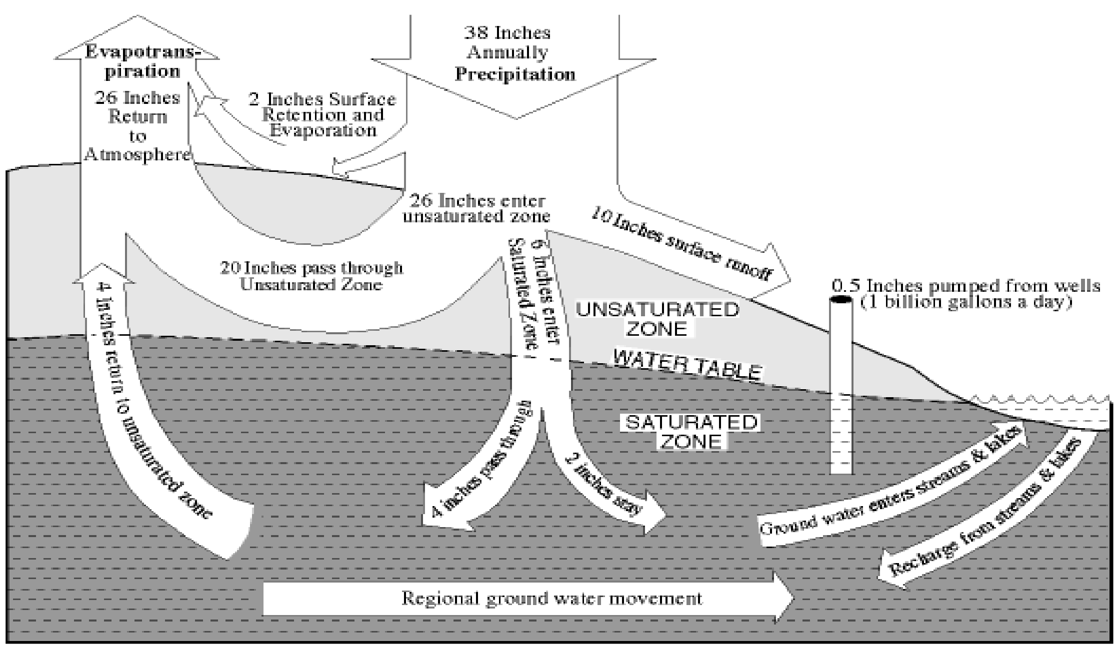


A "hydrologic budget" is an accounting of the inflow to, outflow from and storage in a hydrological unit (such as a lake). "Residence time" is the average length of time particular water stays within a lake before leaving it. This can range from several days to years, depending on the type of lake, amount of rainfall, and other factors. The "flushing rate" is the amount of time it takes for all of the water in a lake to be replaced. The "drainage area" is the amount of area (in acres) contributing surface water runoff and nutrients to the lake. The "areal water load" is the total annual flow volume reaching the lake divided by the surface area of the lake. "Hydraulic loading" is the total annual volume of all water sources (including precipitation, non-point sources & point sources) loading into the lake.

Using the data gathered from historical testing and that done by the Adams County LWCD from 2004-2006, the WiLMS model calculated the tributary drainage area for Goose Lake as 1368.8 acres. The average unit runoff for Adams County in the Goose Lake area is 9.4 inches. WiLMS determined the expected annual runoff volume as 1072.2 acre-feet/year. Anticipated annual hydraulic loading is 1090.5 acre-feet/year. Areal water load is 12.9 feet/year.

In a seepage lake like Goose Lake, water and its nutrient load tend to stay longer within the lake before leaving it than in a lake with an inlet and/or outlet—in Goose Lake's case, modeling estimates a water residence of 0.7 years. Flushing time is 1.44 1-year.

Figure 34: Example of Hydrologic Budget



TROPHIC STATE

The trophic state of a lake is one measure of water quality, basically defining the lake's biological production status (See Figure 35). **Eutrophic lakes** are very productive, with high nutrient levels, frequent algal blooms and/or abundant aquatic plant growth. **Oligotrophic lakes** are those low in nutrients with limited plant growth and small populations of fish. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; often with a more varied fishery than either the eutrophic or oligotrophic lakes. In comparing water quality testing results with the prediction from the computer modeling of this modeling with the actual figures outlined above, the actual Trophic State of Goose Lake is what was predicted from the modeling. Modeling results predicted that the overall TSI for Goose Lake would be **47**. This score places Goose Lake's overall TSI above the average overall TSI for natural lakes in Adams County of 43.88.

Figure 35: Trophic Status Table

Goose Lake = 47 →

Score	TSI Level Description
30-40	**Oligotrophic:** clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
40-50	**Mesotrophic:** moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
50-60	**Mildly Eutrophic:** decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
60-70	**Eutrophic:** dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state. As discussed earlier, the average summer epilimnetic total phosphorus for Goose Lake was 16.85 micrograms/liter. The average summer chlorophyll-a concentration was 5.63 micrograms/liter. Growing season water clarity averaged a depth of 7.1 feet. Figure 36 shows where each of these measurements from Goose Lake fall in trophic level.

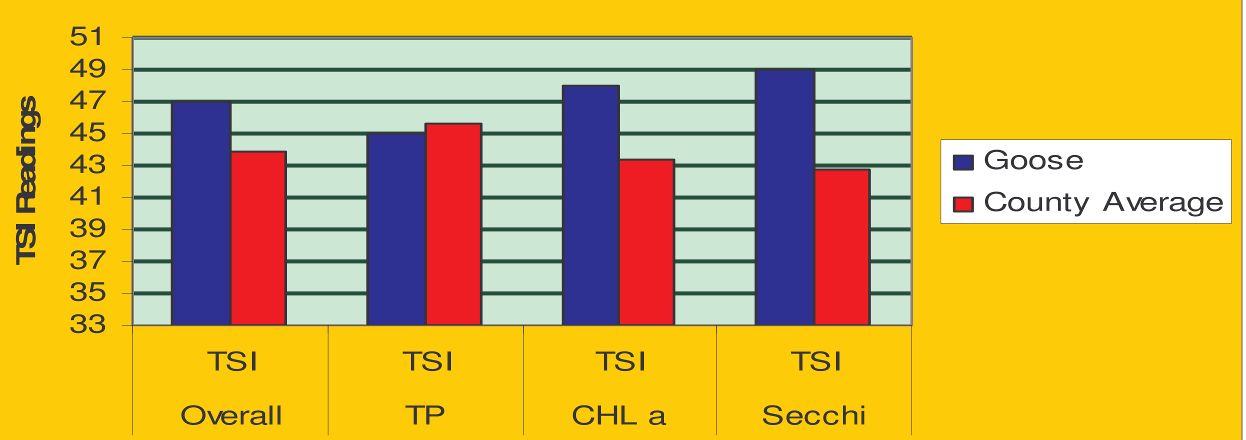
Figure 36: Goose Lake Trophic Status Overview

Trophic State	Quality Index	Phosphorus	Chlorophyll a	Sechhi Disk
		(ug/l)	(ug/l)	(ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	1 to 5	8 to 19
Mesotrophic	Good	**10 to 30**	**5 to 10**	**6 to 8**
	Fair	30 to 50	10 to 15	5 to 6
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
Goose Lake		**16.85**	**5.63**	**7.1**

These figures show that Goose Lake has low levels overall for the three parameters often used to describe water quality: Secchi disk depths; average TP for the growing season; and chlorophyll a levels. It is normal for all of these values to fluctuate during a growing season. However, they can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events. According to these results, Goose Lake scores as "mesotrophic" lake in all three readings. With such phosphorus readings and chlorophyll a readings, dense plant growth and frequent algal blooms would not be expected.

Goose Lake ranks slightly higher in all parameters than the average natural lake in Adams County, as shown in Figure 37. In the TSI index, this is not a positive factor.

Figure 37: Trophic State Index: Goose Lake



IN-LAKE HABITAT

Aquatic Plants

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of the most tolerant species.

An aquatic plant survey was done on Goose Lake in the summer of 2006 by staff from the WDNR and the Adams County LWCD. Goose Lake is a mesotrophic lake with good water quality and clarity. Water clarity has decreased since 1993. Filamentous algae are common in Goose Lake, found at 40% of the sample sites. The aquatic plant community colonized 100% of Goose Lake's Lake littoral zone to a maximum rooting depth of 11 feet. The 0-1.5 foot depth zone supported the most abundant aquatic plant growth, although the 1.5 foot to 5 foot depth zone wasn't far behind.

The Goose Lake aquatic plant community is characterized by high quality and excellent species diversity. The plant community is in the top quartile of lakes in the state and region, the group of lakes closest to an undisturbed condition and with an average sensitivity to disturbance. Several sensitive species were found there, including one on the "special concern" list, *Eleocharis robbinsii* (Robbin's spikerush).

Brasenia schreberi (watershield) was the most frequently-occurring plant in Goose Lake in 2006 (67.44% frequency), followed closely by *Myriophyllum spicatum* (62.79%) and *Nymphaea odorata* (60.47%). No other species reached a frequency of 50% or greater.

Brasenia schreberi was also the densest plant in Goose Lake. None of the aquatic vegetation in Goose Lake occurred at more than average density overall in the lake in summer 2006. *Brasenia schreberi* and *Nymphaea odorata* occurred at slightly more than average density in Depth Zone 1 (0-1.5 feet). *Najas guadelupensis* occurred at more than average density in Depth Zone 2 (1.5 feet -5 feet) and in Depth Zone 3 (5 feet-10 feet). *Potamogeton zosteriformis* occurred at a more than average density in Depth Zone 4.

Based on dominance value, *Brasenia schreberi* was the dominant aquatic plant species in Goose Lake. Subdominant species were the invasive, *Myriophyllum spicatum (*Eurasian watermilfoil), *Najas guadelupensis* (Southern naiad), and *Nymphaea odorata* (white water lily). *Lythrum salicaria* (Purple Loosestrife) *Potamogeton crispus* (Curly-Leaf Pondweed) and *Phalaris arundinacea* (Reed Canarygrass), three other exotics found in Goose Lake, were not present in high frequency, high density or high dominance.

Of the 42 aquatic species found in the survey in 2006, sixteen were emergents, four were rooted floating-leaf plants, and twenty-two were submergent plants, including thirteen sensitive species. Such sensitive species only occur in lakes of little disturbance.

The study used the results of the 2006 field survey to evaluate Goose Lake by using several standard community measurements. For example, the Simpson's Diversity Index was 0.94, indicating very good species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable).

The Aquatic Macrophyte Community Index (AMCI) for Goose Lake is 57. This is in the upper quartile of lakes in Wisconsin and the North Central Hardwoods Region of the state. This value places Goose Lake in the top 25% of lakes in the state and region with the highest quality aquatic plant communities.

The Average Coefficient of Conservatism of 6.92 for Goose Lake was above average for Wisconsin lakes and in the highest quartile for lakes in the North Central Hardwood Region. This suggests that the aquatic plant community in Goose Lake has a high sensitivity to disturbance for Wisconsin lakes and a high sensitivity for lakes in the region.

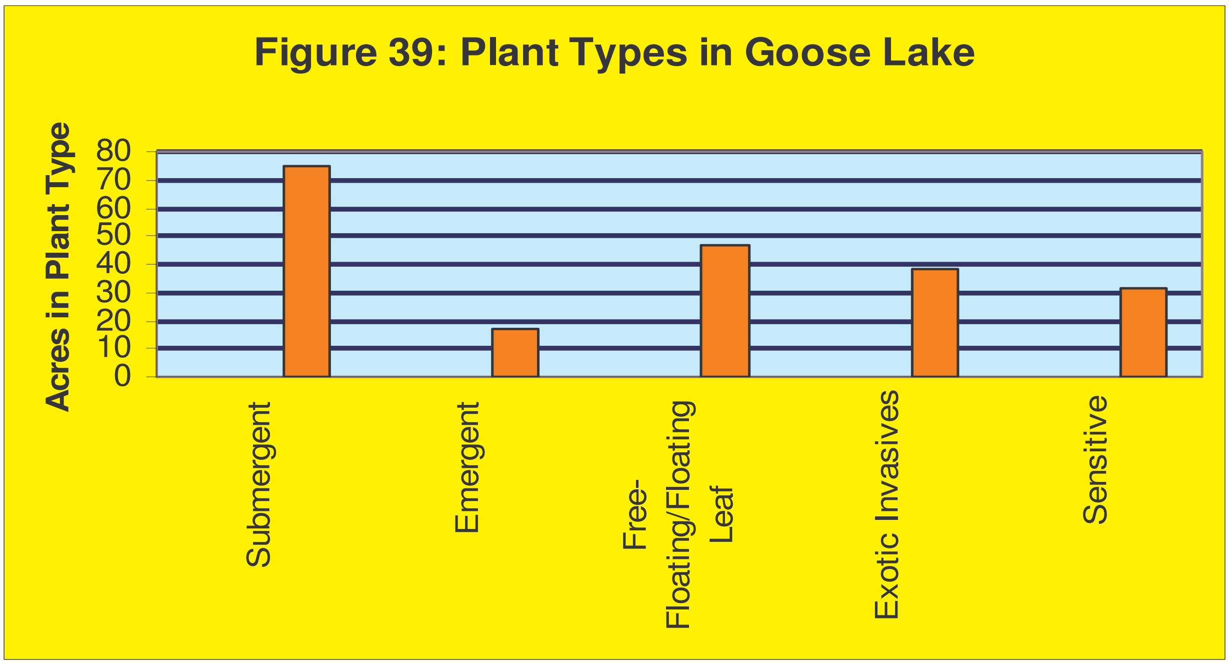
The Floristic Quality Index of the aquatic plant community in Goose Lake of 38.57 is quite above average for Wisconsin Lakes (22.2) and the North Central Hardwood Region (20.9). This indicates that the plant community in Goose Lake is farther from an undisturbed condition than the average lake in Wisconsin overall and in the North Central Hardwood Region. In other words, the aquatic plant community in Goose Lake has been not been impacted by an above average amount of disturbance.

.

Figure 38: Goose Lake Aquatic Plant Species 2005

Scientific Name	Common Name	Plant Type
Asclepias incarnata	Swamp Milkweed	Emergent
Brasenia schreberi	Watershield	Floating-Leaf
Cephalanthus occidentalis	Common Buttonbush	Emergent
Carex crawfordii	Crawford's Sedge	Emergent
Carex hystericina	Bottlebrush Sedge	Emergent
Ceratophyllum demersum	Coontail	Submergent
Chara spp	Muskgrass	Submergent
Cladium mariscoides	Twig Rush	Emergent
Eleocharis acicularis	Needle Spikerush	Emergent
Eleocharis robbinsii	Robbin's Spikerush	Submergent
Elodea canadensis	Waterweed	Submergent
Juncus pelocarpus	Brownfruit Rush	Submergent
Lysmachia quadriflora	4-Flower Yellow Loosestrife	Emergent
Lythrum salicaria	Purple Loosestrife	Invasive
Myriophyllum sibiricum	Northern Milfoil	Submergent
Myriophyllum spicatum	Eurasian Watermilfoil	Invasive
Najas flexilis	Bushy Pondweed	Submergent
Najas guadelupensis	Southern Naiad	Submergent
Nuphar variegata	Varigated Yellow Pond Lily	Floating-Leaf
Nymphaea odorata	White Water Lily	Floating-Leaf
Phalaris arundinacea	Reed Canarygrass	Invasive
Polygonum amphibium	Water Smartweed	Floating-Leaf
Potamogeton illinoensis	Illinois Pondweed	Submergent
Potamogeton praelongus	White-Stemmed Pondweed	Submergent
Potamogeton pusillus	Small Pondweed	Submergent
Potamogeton richardsonii	Clasping-Leaf Pondweed	Submergent
Potamogeton zosteriformis	Flat-Stemmed Pondweed	Submergent
Potentilla palustris	Marsh Cinquefoil	Emergent
Sagittaria spp	Duck Potato/Arrowhead	Emergent
Sarracenia purpurea	Purple Pitcher Plant	Emergent
Scirpus pungens	Common 3-Square Bulrush	Emergent
Scirpus subterminalis	Water Bulrush	Emergent
Scirpus validus	Soft-Stem Bulrush	Emergent
Thelypteris palustris	Marsh Fern	Emergent
Typha angustifolia	Narrow-Leaf Cattail	Emergent
Typha latifolia	Wide-Leaf Cattail	Emergent
Utricularia gemniscapa	Twin-Stemmed Bladderwort	Submergent
Utricularia gibba	Creeping Bladderwort	Submergent
Utricularia intermedia	Flat-Leaved Bladderwort	Submergent
Utricularia minor	Lesser Bladderwort	Submergent
Utricularia vulgaris	Common Bladderwort	Submergent
Vallisneria americana	Water Celery	Submergent

Based on water clarity, chlorophyll and phosphorus data, Goose Lake is a mesotrophic lake with good water clarity and quality. The current trophic state would support moderate plant growth and occasional algae blooms. Filamentous algae occurred at 40% of the sites and were most common in the 0-5 foot depth zone. Adequate nutrients (trophic state), the good water clarity, the moderately hard water and the gradually sloped littoral zone in Goose Lake would favor plant growth.



A comparison of the aquatic plant community in Goose Lake from disturbed shorelines and undisturbed shorelines was also part of the 2006 Aquatic Plant Survey evaluation. Disturbed cover, including cultivated lawn, rock riprap, pavement and hard structures, covered 19.71% of the shoreline. Shorelines with cultivated lawn can impact the plant community through increased run-off of lawn fertilizers, pesticides and pet wastes into the lake. Hard structures and mowed lawn also speed run-off to the lake without filtering these pollutants. Expanding and protecting the buffer of natural vegetation along the shore will help prevent shoreline erosion and reduce additional nutrient/chemical run-off that can add to algae growth and sedimentation of the lake bottom.

Using these figures, the natural, undisturbed shores had higher readings for Number of Species, Floristic Quality Index, Average Coefficient of Conservatism and Simpson's Index of Diversity. The natural shores also had less filamentous algae.

Figure 40:	Comparison	of shore types
	Natural	**Disturbed**
Number of species	35	27
FQI	35.67	30.79
Average Coef. Of Cons	6.03	5.93
Simpson's Index	0.94	0.93
Filamentous algae	39%	45%

The quality of the aquatic plant community at the natural shoreline sites is greater than the quality of the plant community at the disturbed sites. The higher quality is due to a higher frequency of occurrence of sensitive aquatic plant species (Nichols 2000) at natural shoreline communities and lack of exotic species at natural shoreline sites. The most sensitive species in Goose Lake occurred at a much higher frequency, grew at a higher density and had a higher dominance at the sites near natural shoreline This corroborates the impact disturbed shoreline has on the aquatic plant community. Eurasian Watermilfoil had a 12% relative frequency at the disturbed shores, only a 7% frequency at the natural shores. It also had denser growth at the disturbed sites. Disturbance creates an ideal condition for the invasion of exotic species such as Eurasian Watermilfoil.

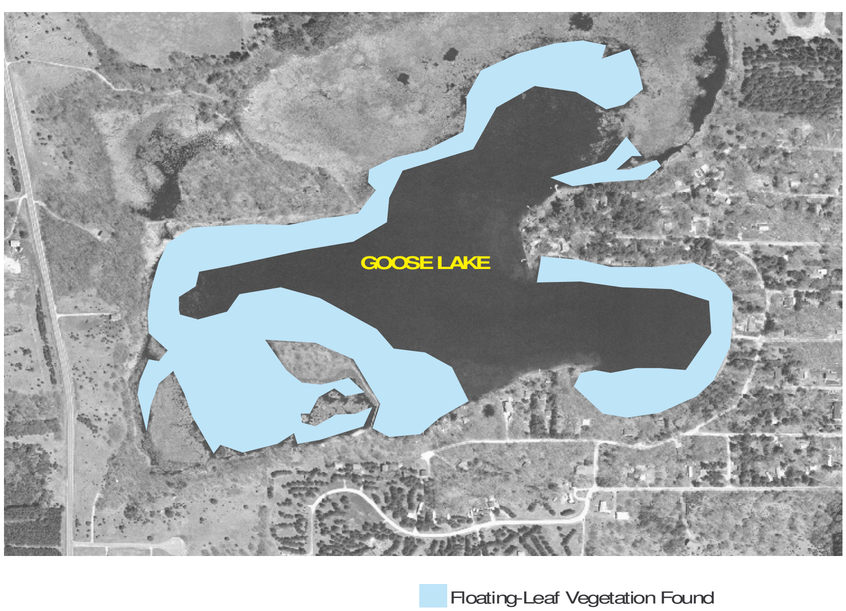
The cover of submergent vegetation, emergent vegetation and floating-leaf vegetation was higher at natural shoreline plant communities. The higher occurrence of emergent and floating-leaf species at natural sites is particularly important from the habitat view. These species are especially valuable for habitat and, with the submergent vegetation, they add a diversity of structural types which supports greater diversity in the fish and wildlife community. Even the species frequency, density and dominance varied. At the disturbed sites, the highest species in frequency, density and dominance were the invasive, *Myriophyllum spicatum,* and a native plant, *Najas guadelupensis.* At the undisturbed sites, the two species found with the most frequency, the highest density and the most dominance were *Brasenia schreberi* and *Nymphaea odorata,* both native species.

Filamentous algae occurred at a higher percentage of sites at disturbed shoreline as compared to natural shoreline. This suggests nutrient enrichment at disturbed shoreline sites. Nutrient sources could be lawn fertilizers, failing or poorly maintained septic systems, pet wastes and poorer filtering capacity of hard surfaces and mowed lawns.

Figure 41a: Emergent Aquatic Plants Distribution in Goose Lake (2006)

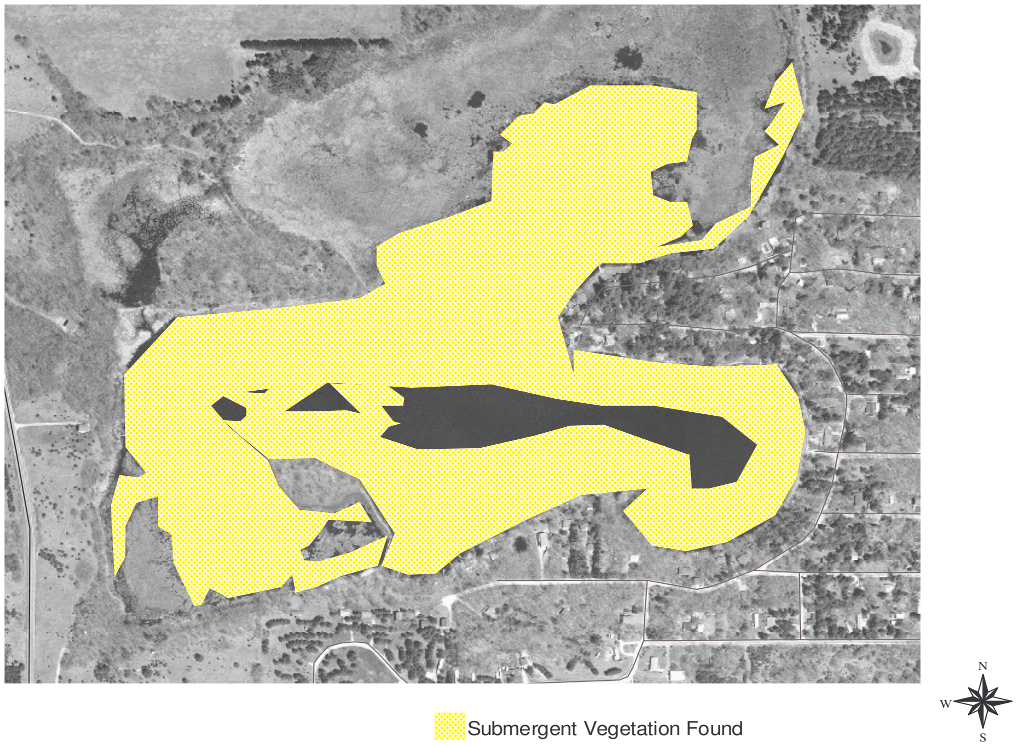
RE:10/06

Figure 41b: Floating Leaf Plants Distribution in Goose Lake (2006)



RE:10/06

Figure 41c: Submergent Aquatic Species Distribution in Goose Lake (2006)



RE:10/06

Figure 42: Undisturbed Shore at Goose Lake

Figure 43: Most Common Native Aquatic Species in GooseLake

Nymphaea odorata
(White Water Lily)

Najas guadelupensis
(Southern naiad)

Brasenia schreberi
(Watershield)

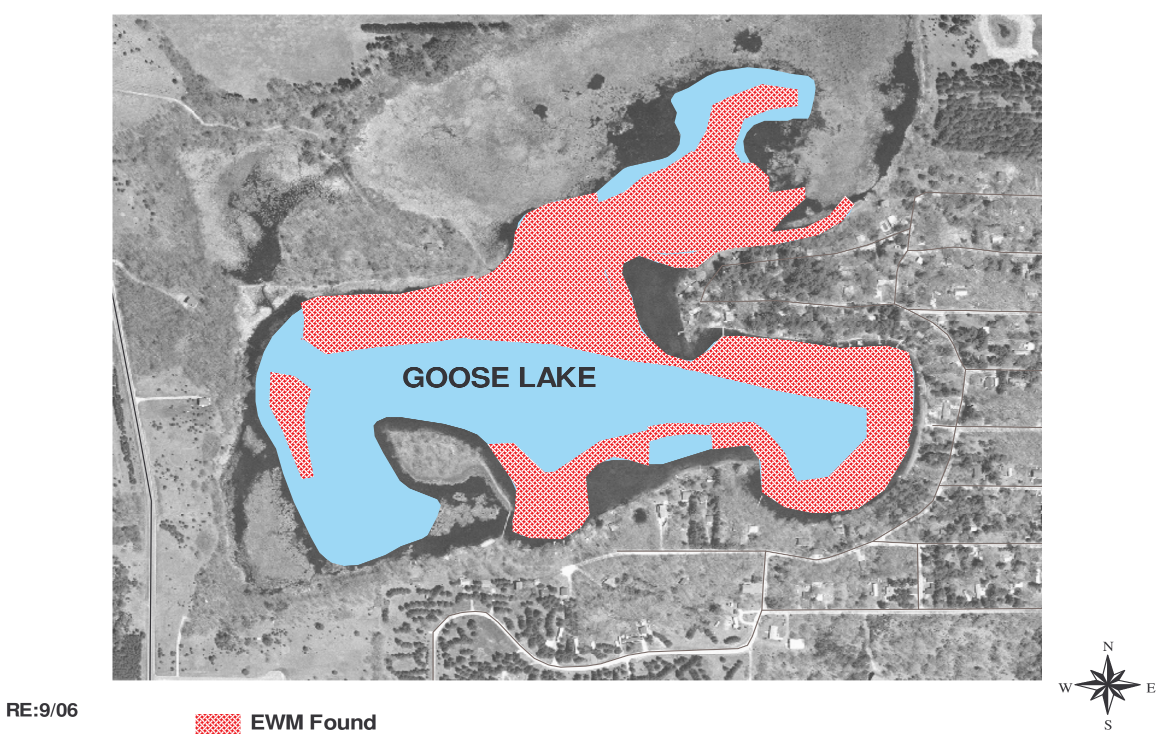
Aquatic Invasives

The invasive Eurasian Watermilfoil has been in Goose Lake for some years. It tends to accumulate in large mats in the shallower areas of the lake, including right off the boat ramp. Based on its distribution pattern, during much of the summer it is impossible for a boat to launch at the public boat ramp and travel to other parts of the lake without going through Eurasian Watermilfoil and spreading it by fragmentation. The Goose Lake Association has chemically spot-treated the lake for several years in an attempt to control the spread of EWM.

Although Curly-Leaf Pondweed, Purple Loosestrife and Reed Canarygrass are also found at Goose Lake, none of them occur in significant frequency or density at this time.

A survey in 2007 indicated that the native weevil, *Euhrychiopsis lecontei*, was present in parts of Goose Lake. This weevil, if present in sufficient density, can weaken Eurasian milfoil plants to the point of death.

Figure 44: Distribution of Eurasian Watermilfoil in 2006



In 2007, Chinese mystery snails (*Bellamya japonica*) and Banded mystery snails *(Viviparus georgiana)* were found in Goose Lake. These are relatively new invaders to Wisconsin. The WDNR and Center for Limnology at UW-Madison are currently studying these snails in an attempt to better determine their potential impact on Wisconsin lake ecosystems. They are analyzing the data to see how the snail's presence correlates with native snail abundance, water chemistry, etc. The Center for Limnology has also completed a large, outdoor experiment examining how Chinese mystery snails and rusty crayfish affect native snails. The preliminary results are clear-cut -- both invaders have strong negative effects on the natives. The Chinese mystery snail, owing to its larger size, is relatively immune from rusty crayfish attack while other snails are often fed on by the rusty crayfish.

There is no legal chemical control method for mystery snails in Wisconsin. Any chemical that have the potential to control Chinese and banded mystery snails would impact the native snails, clams and other organisms and is illegal.

Chinese Mystery Snail

Banded Mystery Snail

Figure 45: Photos of the Invasive Mystery Snails

Figure 46: Invasive Aquatic Plants Known to Occur in GooseLake: *Myriophyllum spicatum* (Eurasian Watermilfoil); *Potamogeton cripus* (Curly-Leaf Pondweed); *Phalaris arundinacea* (Reed Canarygrass); and *Lythrum salicaria* (Purple Loosestrife)

Eurasian Watermilfoil

Curly-Leaf Pondweed

Reed Canarygrass

Purple Loosestrife

Critical Habitat

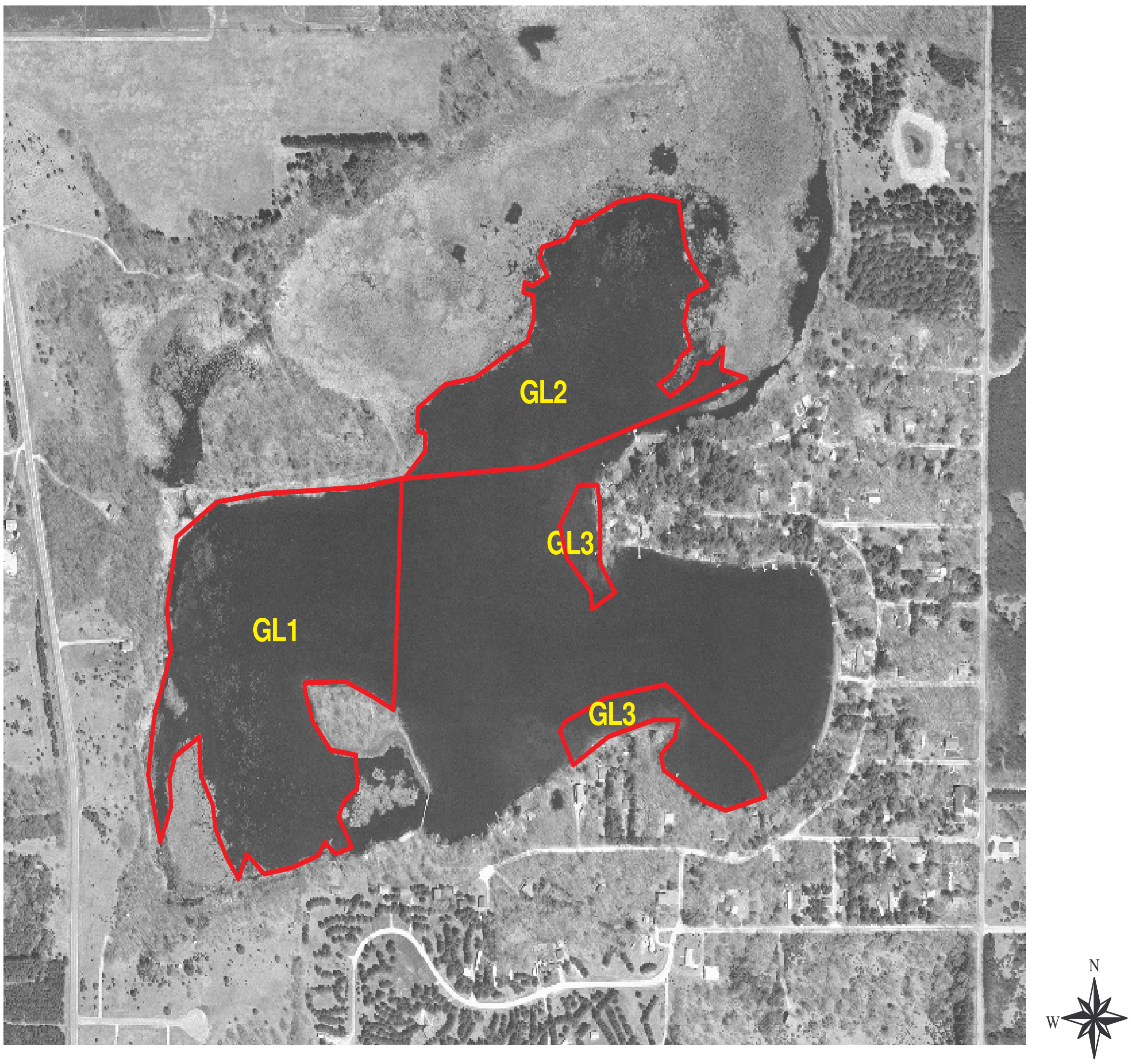
Designation of critical habitat areas within lakes provides a holistic approach for assessing the ecosystem and for protecting those areas in and near a lake that are important for preserving the qualities of the lake. Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes.

Protection of critical habitat areas must include protecting the shore area plant community, often by buffers of native vegetation that absorb or filter nutrient & stormwater runoff, prevent shore erosion, maintain water temperature and provide important native habitat. Buffers can serve not only as habitats themselves, but may also provide corridors for species moving along the shore.

Besides protecting the landward shore areas, preserving the littoral (shallow) zone and its plant communities not only provides essential habitat for fish, wildlife, and the invertebrates that feed on them, but also provides further erosion protection and water quality protection.

Field work for a critical habitat area study was performed on August 14, 2001, on Goose Lake, Adams County. The study team included: Scot Ironside, DNR Fish Biologist; Terence Kafka, DNR Water Regulation; James Keir, DNR Wildlife Biologist; Rhonda Kenyon, DNR Water Regulation & Zoning Specialist; Deborah Konkel, DNR Aquatic Plant Specialist; and Patrick (Buzz) Sorge, DNR Lakes Manager. A follow-up field review was done in summer 2006 by Deb Konkel of the WDNR and Reesa Evans, Adams County Land & Water Conservation Department. Areas were identified visually, with GPS readings and digital photos providing additional information

Figure 47: Critical Habitat on Goose Lake



RE:9/06

CRITICAL HABITAT AREA GL1—WEST BASIN

This basin averages 5 feet in depth and contains near-shore habitat, shoreline habitat and shallow water habitat. The basin provides visual and sound buffers and an area of outstanding beauty for lake residents and visitors. Most of this shoreline is undeveloped, although some lots have been occupied since the original 2001 site visit. Most of the shore is wooded or wetland. Woody material is present in the shallow zone for habitat. The wetlands contain wet meadows, shrubs, evergreen wetlands and deep marsh wetlands.

The plant community in this area consists of nine species emergent aquatic plants, three species of floating-leaf rooted plants, and eleven species of submergent plants. Three invasive species, *Lythrum salicaria* (Purple Loosestrife, an emergent), *Myriophyllum spicatum* (Eurasian Watermilfoil, a submergent) and *Phalaris arundinacea* (Reed Canarygrass, an emergent) were found in this area.

Maintaining the integrity of this area is important to protect the water quality of Goose Lake. The submerged and floating-leaf vegetation take up nutrients into their tissues that would otherwise be available for algae growth or overly-dense plant growth. The emergent vegetation on the west shore filters water that runs off the steep west shore. The submergent vegetation is protecting the lake bottom from resuspension of the fertile muck and peat sediments by boat traffic and wind action, thus maintaining clarity.

The fallen woody debris along the shore and mosaic of submerged vegetation and floating-leaf vegetation with an open area provides a diversity of habitat and feeding opportunities for the fish community. This basin provides spawning, nursery, feeding and cover for northern pike, large-mouth bass, perch, panfish, suckers and bullheads.

The variety of emergent vegetation, floating-leaf vegetation, shrubs and snag trees provide cover and feeding areas for upland wildlife; shelter, cover, nursery and feeding areas for beaver, otter, muskrat & mink; cover, nesting & feeding for raptors, ducks, songbirds and geese; cover, feeding & nesting for amphibians and reptiles.

Figure 48: View of GL1 Southeast side

CRITICAL HABITAT AREA GL2—NORTH BASIN

This area averages 6.5 feet in depth and contains near shore habitat, shoreline habitat and shallow water habitat. The basin provides visual and sound buffers and an area of outstanding beauty for lake residents and visitors. Most of this shoreline is undeveloped, although some lots have been occupied since the original 2001 site visit. Most of the shore is wooded or wetland. Woody material is present in the shallow zone for habitat. The wetlands contain wet meadows, shrubs wetlands, tamarack bogs, and deep marsh wetlands.

The plant community in this area consists of at least eight emergent species, four floating-leaf rooted plant species, and nine species of submergents. Emergents include: sedges, dogwood, water bulrush, marsh fern, tag alder, tamarack, cattail, and bulrush. In 2006, a species of special concern, *Eleocharis robbinsii* (Robbin's Spikerush), was also found in this area. Several other high-quality aquatic species, including *Cephhalanthus occidentalis* (Buttonbush), *Cladium marisicoides* (Twig Rush), *Lysmachia quadriflor* (4-Flower Yellow Loosestrife) and *Sarracenia purpurea*

(Purple Pitcher Plant)—were also found in this area. Two invasives, Eurasian Watermilfoil and Reed Canarygrass, were also found in GL2.

Maintaining the integrity of this area is important to protect the water quality of Goose Lake. The submerged and floating-leaf vegetation take up nutrients into their tissues that would otherwise be available for algae growth or overly-dense plant growth. The emergent vegetation on the west shore filters water that runs off the steep west shore. The submergent vegetation is protecting the lake bottom from resuspension of the fertile muck and peat sediments by boat traffic and wind action, thus maintaining clarity.

Figure 49: Close-Up of West Side of GL2

CRITICAL HABITAT AREA GL3

This area was added after a field review in 2006 by WDNR and Adams County Land & Water Conservation Department staff. It serves as a nutrient buffer zone, as well as a physical and biological buffer. Although there are houses in this area, most of them are set back substantially from the ordinary high water mark, up the slopes. There are dense beds of plants that provide micro-habitat and sediment stabilization. The area contains near shore habitat, shoreline habitat and shallow water habitat.

The area comprises about 1000 feet of shoreline with an average water depth of 4 feet. It is located to the west and south of the public boat ramp on Goose Lake. Sediments found include marl, peat, sand and silt, or mixtures thereof. Vegetation just landward of shore includes mostly native forbs and shrubs, with a small area of traditional lawn and some presence of woody cover.

Northern pike is sometimes found in the area, as well as largemouth bass, suckers and an assortment of panfish. Wildlife including songbirds, geese, amphibians and reptiles are known in Area GL3.

An emergent species of special concern, *Eleocharis robbinsii*, was abundant in this area. Also found were four emergent species, four floating-leaf rooted species, and eleven species of submergent aquatic plants.

Figure 50: Point Area in GL3

Recommendations for Critical Habitat Areas:

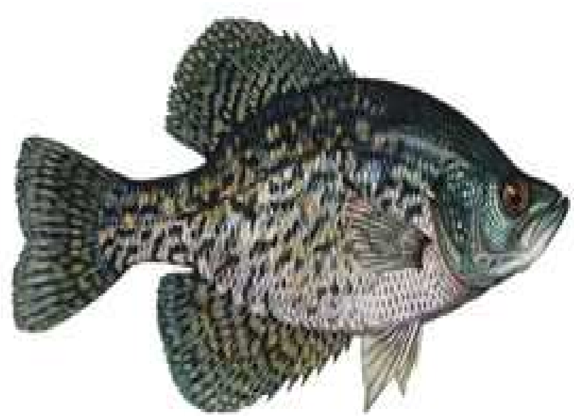
(1) Maintain current habitat for fish and wildlife.
(2) Do not remove fallen trees along the shoreline or from the water.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain snag/cavity trees for nesting.
(6) Install nest boxes.
(7) Maintain or increase wildlife corridors.
(8) Make no-wake zones.
(9) Protect emergent vegetation, especially those with high Coefficients of Conservatism.
(10) Minimize aquatic plant and shore plant removal to maximum 30' wide viewing/access corridor. Leave as much vegetation as possible to protect water quality and habitat.
(11) Use forestry best management practices on shores.
(12) If possible, limit development of this area for housing or similar recreational use while maintaining setbacks and current buffers.
(13) No use of lawn products in shore areas.
(14) No bank grading or grading of adjacent land.
(15) No pier placement, boat landings, development or other shoreline disturbance in the shore area of the wetland corridors.
(16) No pier construction or other activity except by permit using a case-by-case evaluation.
(17) No installation of pea gravel or sand blankets.
(18) No bank restoration unless the erosion index scores moderate or high. Include stormwater runoff management in all shoreline protection designs.
(19) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(20) Placement of swimming rafts or other recreational floating devices only by permit.
(21) Maintain buffer of shoreline vegetation.
(22) Maintain aquatic vegetation buffer in undisturbed condition for wildlife habitat, fish use and water quality protection.
(23) Post invasive species signs at the boat landing.
(24) Continue to monitor & spot-treat the EWM. Develop integrated plan to manage it.
(25) Monitor the other invasive species in the lake and take management action if they spread further.

FISHERY/WILDLIFE/ENDANGERED RESOURCES

WDNR fish stocking records for Goose Lake go back to 1937, when several thousand bullheads were put into the lake. Stocking continued into the 1970s and included more bullheads, as well as bluegill, crappie, largemouth bass, northern pike, perch and sunfish. There was a long history of fish winterkills, until the current aerators were installed. The most recent fish inventory, in 2004, found that bluegills were abundant, largemouth bass were common, but northern pike and black crappie were scarce.

Muskrat and mink are also known to use Goose Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl, songbirds, and turkey. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well.

Figure 51: Two of the fish found in Goose lake—Largemouth Bass (to the left) and Black Crappie (below)



RESOURCES

Bryan, B., B. Charry. 2006. Conserving Wildlife in Maine's Shoreland Habitats. Maine Audobon Society.

Carlson, R.E. 1977. A Trophic State Index for Lakes. Limnology and Oceanography 22:361-369.

Dennison, W., R. Orth, K. Moore, J. Stevenson, V. Carter, S. Kollar, P. Bergstrom, R. Batuik. 1993. Assessing Water Quality with Submersed Vegetation. Bioscience 43(2):86-94.

Engel, S. 1985. Aquatic Community Interactions of Submerged Macrophytes. Wisconsin Department of Natural Resources Bulletion #156.

Frankenberg, J. Land Use and Water Quality. Purdue Extension Publication ID-230.

James, T. 1992. A Guidebook for Lake Associations. The International Coalition for Land and Water Stewardship in the Red River Basin, Minnesota.

Kibler, D.F., ed. 1982. Urban Stormwater Hydrology. Water Resources Monograph 7. American Geophysical Union.

Krysel, C, E.M. Boyer, C. Parson, P. Welle. 2003. Lakeshore Property Values and Water Quality: Evidence from Property Sales in the Mississippi Headwaters Region. Report to the Legislative Commission on Minnesota Resources.

Lillie, R.A., J.W. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. Department of Natural Resources Bulletin No. 138.

Nichols, S. 1998. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management 15(2):133-141.

Nichols, S., S. Weber, B. Shaw. 2000. A Proposed Aquatic Plant Community Biotic Index for Wisconsin Lakes. Environmental Management 26(5): 491-562.

Shaw, B., C. Mechanich, L. Klessing. Understanding Lake Data. UW-Extension Publication SR-02/2002-1M-525, 2000.

Terrell, C., P. Perfetti. 1989. Water Quality Indicators Guide: Surface Waters. United States Department of Agriculture Publication SCS-TP-161.

Wagner, C., J. Haack, R. Korth. Protecting Our Living Shores. 2003. Shoreland Stewardship Series #3 WDNR Publication WT-764-2003. UW-Extension, Wis. Lakes Partnership, WDNR, Wisconsin Association of Lake & River Alliance of Wisconsin.